CISCO

SD-WAN

Configure From Scratch

FULL LAB DOCUMENTATION

MUHAMMAD RIDHO CAHYO

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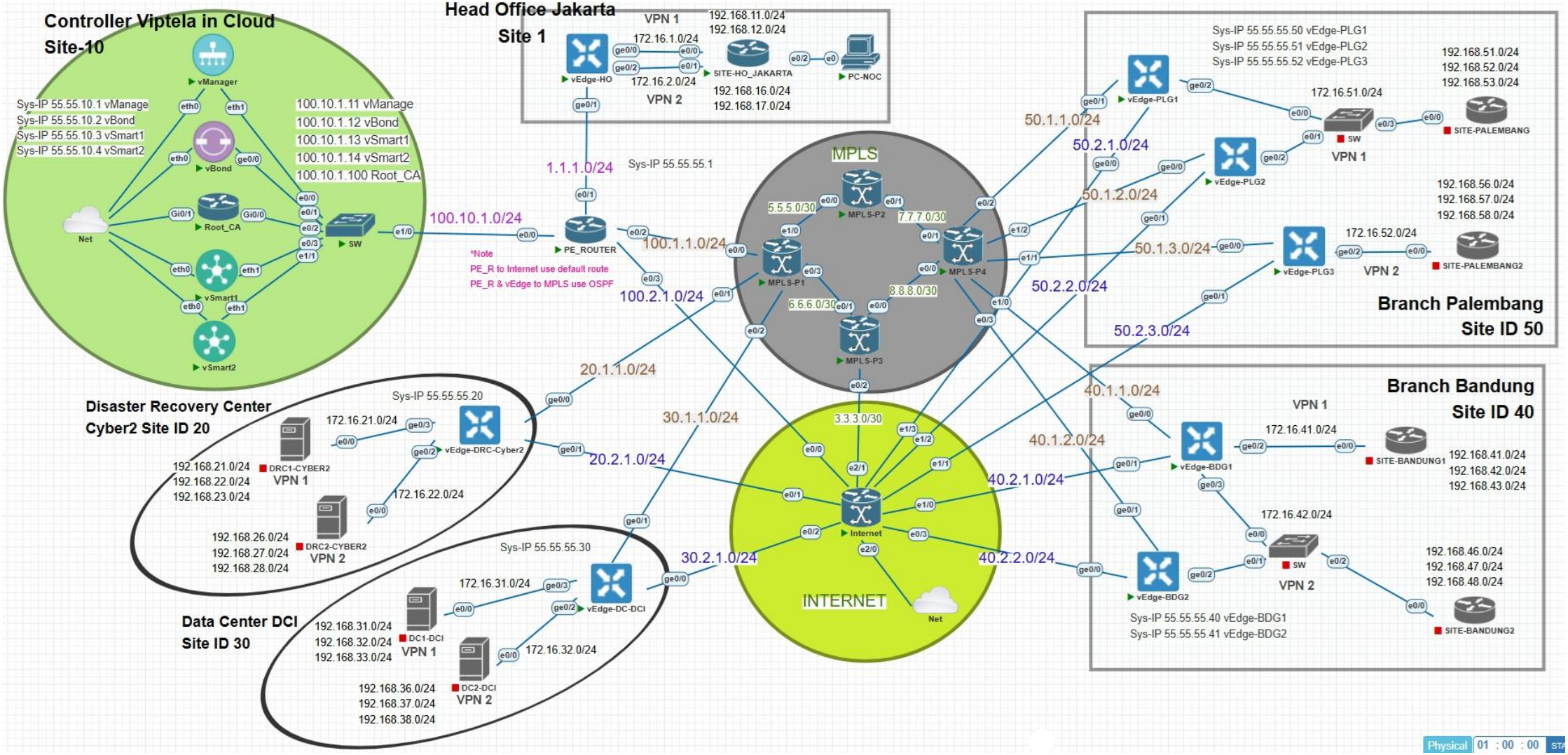
TOPOLOGY


Controller Viptela in Cloud
Site-10
vManager
vBond
Root_CA
SW
vSmart1
vSmart2
Net
Sys-IP 55.55.10.1 vManage
Sys-IP 55.55.10.2 vBond
Sys-IP 55.55.10.3 vSmart1
Sys-IP 55.55.10.4 vSmart2
100.10.1.11 vManage
100.10.1.12 vBond
100.10.1.13 vSmart1
100.10.1.14 vSmart2
100.10.1.100 Root_CA
Head Office Jakarta
Site 1
vEdge-HO
SITE-HO_JAKARTA
PC-NOC
VPN 1
172.16.1.0/24
172.16.2.0/24
VPN 2
192.168.11.0/24
192.168.12.0/24
192.168.16.0/24
192.168.17.0/24
1.1.1.0/24
Sys-IP 55.55.55.1
100.10.1.0/24
PE_ROUTER
*Note
PE_R to Internet use default route
PE_R & vEdge to MPLS use OSPF
100.1.1.0/24
100.2.1.0/24
MPLS
MPLS-P1
MPLS-P2
MPLS-P3
MPLS-P4
5.5.5.0/30
6.6.6.0/30
7.7.7.0/30
8.8.8.0/30
Sys-IP 55.55.55.50 vEdge-PLG1
Sys-IP 55.55.55.51 vEdge-PLG2
Sys-IP 55.55.55.52 vEdge-PLG3
vEdge-PLG1
vEdge-PLG2
vEdge-PLG3
SW
VPN 1
VPN 2
SITE-PALEMBANG
SITE-PALEMBANG2
192.168.51.0/24
192.168.52.0/24
192.168.53.0/24
192.168.56.0/24
192.168.57.0/24
192.168.58.0/24
172.16.51.0/24
172.16.52.0/24
50.1.1.0/24
50.2.1.0/24
50.1.2.0/24
50.1.3.0/24
50.2.2.0/24
50.2.3.0/24
Branch Palembang
Site ID 50
Branch Bandung
Site ID 40
vEdge-BDG1
vEdge-BDG2
SITE-BANDUNG1
SITE-BANDUNG2
Sys-IP 55.55.55.40 vEdge-BDG1
Sys-IP 55.55.55.41 vEdge-BDG2
40.1.1.0/24
40.1.2.0/24
40.2.1.0/24
40.2.2.0/24
172.16.41.0/24
172.16.42.0/24
192.168.41.0/24
192.168.42.0/24
192.168.43.0/24
192.168.46.0/24
192.168.47.0/24
192.168.48.0/24
Disaster Recovery Center
Cyber2 Site ID 20
Sys-IP 55.55.55.20
vEdge-DRC-Cyber2
DRC1-CYBER2
DRC2-CYBER2
VPN 1
VPN 2
20.1.1.0/24
20.2.1.0/24
172.16.21.0/24
172.16.22.0/24
192.168.21.0/24
192.168.22.0/24
192.168.23.0/24
192.168.26.0/24
192.168.27.0/24
192.168.28.0/24
Data Center DCI
Site ID 30
Sys-IP 55.55.55.30
vEdge-DC-DCI
DC1-DCI
DC2-DCI
30.1.1.0/24
30.2.1.0/24
172.16.31.0/24
172.16.32.0/24
192.168.31.0/24
192.168.32.0/24
192.168.33.0/24
192.168.36.0/24
192.168.37.0/24
192.168.38.0/24
3.3.3.0/30
Internet
INTERNET
Net
Physical
01 : 00 : 00

In the above topology, the scenario involves an organization named 'MRC' that operates across six sites located in various on-premises and cloud environments, including:

1. Site 1: Head Office, Jakarta
2. Site 10: Controller Viptela (Cloud)
3. Site 20: Data Center Cyber2
4. Site 30: Data Center DCI
5. Site 40: Branch Office, Bandung
6. Site 50: Branch Office, Palembang

This infrastructure uses SD-WAN to manage all connections and orchestration for each site. SD-WAN separates the control-plane and data-plane functions using Cisco Viptela controllers (vManage, vBond, vSmart).

In the underlay network, each site connects to the controllers using two different transport links. One of SD-WAN's advantages is its ability to support multiple transport mediums for underlay interconnection. In this scenario, the transport links used are **Internet** and **MPLS**.

CONFIGURE INTERNET & MPLS ROUTER

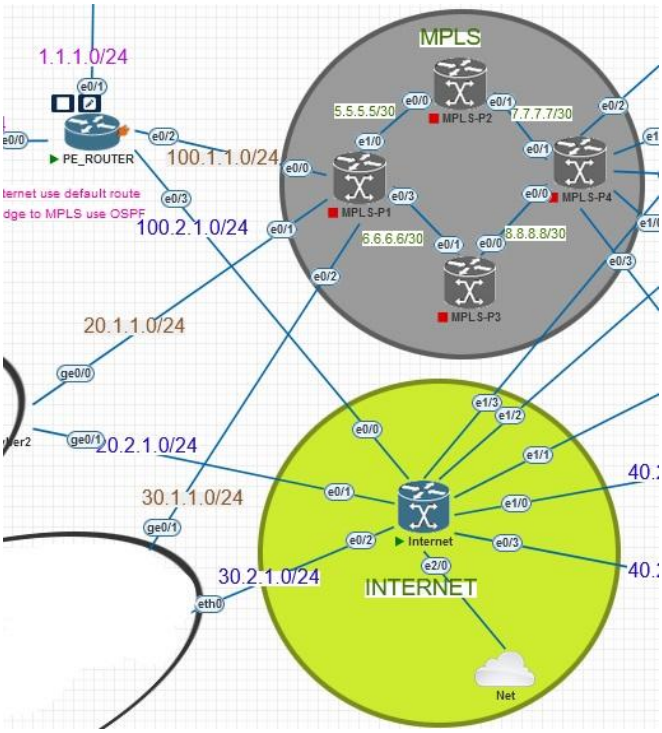
Using dual transport links in SD-WAN has several benefits, including:

1. Redundancy and High Availability
2. Load Balancing
3. Cost Efficiency
4. Traffic Segmentation

SD-WAN can flexibly utilize all its transport links. For example, in traffic segmentation, we can choose specific paths for critical applications requiring security and low latency or select other paths for non-critical/cloud access.

Configuration:

PE_Router, MPLS Backbone, Internet Router



The interconnection used for the MPLS backbone transport link is OSPF routing. For the Internet router, a default route is applied.

PE_Router

```
// Config P2P / Interface & loopback address according to the topology

// Config OSPF
router ospf 1
 router-id 1.1.1.1
 network 1.1.1.0 0.0.0.255 area 0
 network 100.1.1.0 0.0.0.255 area 0
 network 100.10.1.0 0.0.0.255 area 0

// Config MPLS in OSPF
((OSPF automatically functions as the backbone for MPLS interconnection.))
mpls ip
mpls ldp router-id lo0 force
router ospf 1
 mpls ldp autoconfig

// Config Default Route to Internet router
ip route 0.0.0.0 0.0.0.0 100.2.1.2
```

MPLS Backbone

MPLS-P1

```
// Configure P2P / Interface & loopback address according to the topology

// Config OSPF (MPLS interconnection)
router ospf 1
 router-id 2.2.2.1
 network 0.0.0.0 255.255.255.255 area 0
```

```
// Config MPLS in OSPF
mpls ip
mpls ldp router-id lo0 force
router ospf 1
 mpls ldp autoconfig
```

MPLS-P2

```
// Configure P2P / Interface & loopback address according to the topology

// Config OSPF (MPLS interconnection)
router ospf 1
 router-id 2.2.2.2
 network 0.0.0.0 255.255.255.255 area 0

// Config MPLS in OSPF
mpls ip
mpls ldp router-id lo0 force
router ospf 1
 mpls ldp autoconfig
```

MPLS-P3

```
// Config P2P / Interface & loopback address according to the topology

// Config OSPF (MPLS interconnection)
router ospf 1
 router-id 2.2.2.3
 network 0.0.0.0 255.255.255.255 area 0

// Config MPLS in OSPF
mpls ip
mpls ldp router-id lo0 force
```

```
router ospf 1
 mpls ldp autoconfig
```

MPLS-P4

```
// Config P2P / Interface & loopback address according to the topology

// Config OSPF (MPLS interconnection)
router ospf 1
 router-id 2.2.2.4
 network 0.0.0.0 255.255.255.255 area 0

// Config MPLS in OSPF
mpls ip
mpls ldp router-id lo0 force
router ospf 1
 mpls ldp autoconfig
```

Internet Router

```
// Config P2P / Interface & loopback address according to the topology

// Setup Internet
interface Ethernet2/0
  description TO INTERNET PUBLIC INTERNET
  ip address dhcp
end
!

# Default route to the internet gateway
ip route 0.0.0.0 0.0.0.0 192.168.18.33
!
```

```
# Config NAT
access-list 10 permit any
!
ip nat inside source list 10 interface Ethernet2/0 overload
!
interface range Ethernet0/0-3, Ethernet1/0-3
 ip nat inside
!
interface Ethernet2/0
 ip nat outside

// Static route to all Site segments
ip route 1.1.1.0 255.255.255.0 100.2.1.1
ip route 100.10.1.0 255.255.255.0 100.2.1.1
ip route 172.16.1.0 255.255.255.0 100.2.1.1
ip route 172.16.20.0 255.255.255.0 20.2.1.1
ip route 172.16.30.0 255.255.255.0 30.2.1.1
ip route 172.16.40.0 255.255.255.0 40.2.2.1
ip route 172.16.40.0 255.255.255.0 40.2.1.1
ip route 172.16.50.0 255.255.255.0 50.2.3.1
ip route 172.16.50.0 255.255.255.0 50.2.2.1
ip route 172.16.50.0 255.255.255.0 50.2.1.1
!
```

CONFIGURE SD-WAN CONTROLLER

VMANAGE, VSMART, VBOND

In this section, we will configure the controllers (vManage, vBond, vSmart). SD-WAN technology introduces the concept of VPNs to isolate traffic and provide network segmentation. These VPNs function similarly to Virtual Routing and Forwarding (VRF), meaning that each VPN has its own routing table and can be managed independently.

There are several types of VPNs in Viptela SD-WAN with different functions:

1. VPN 0 (Transport VPN)
   - Used for transport connectivity between SD-WAN devices and the edge network.
   - Utilizes physical interfaces/tunnels to establish connections to the WAN/Internet.
   - Typically connected to WAN or transport links (MPLS, Internet, or LTE).
   - All communication between SD-WAN devices through the overlay network occurs via VPN 0.
   - Establishes IPSec tunnels between SD-WAN devices.
   - Handles all **OMP (Overlay Management Protocol), BFD (Bidirectional Forwarding Detection)**, and **DTLS/TLS** communication with vSmart, vBond, and vManage.

2. VPN 512 (Management VPN)
   - Connects SD-WAN devices to the management network (SSH, SNMP, API).
   - Provides out-of-band connectivity separated from data VPNs, ensuring no interference with production traffic.

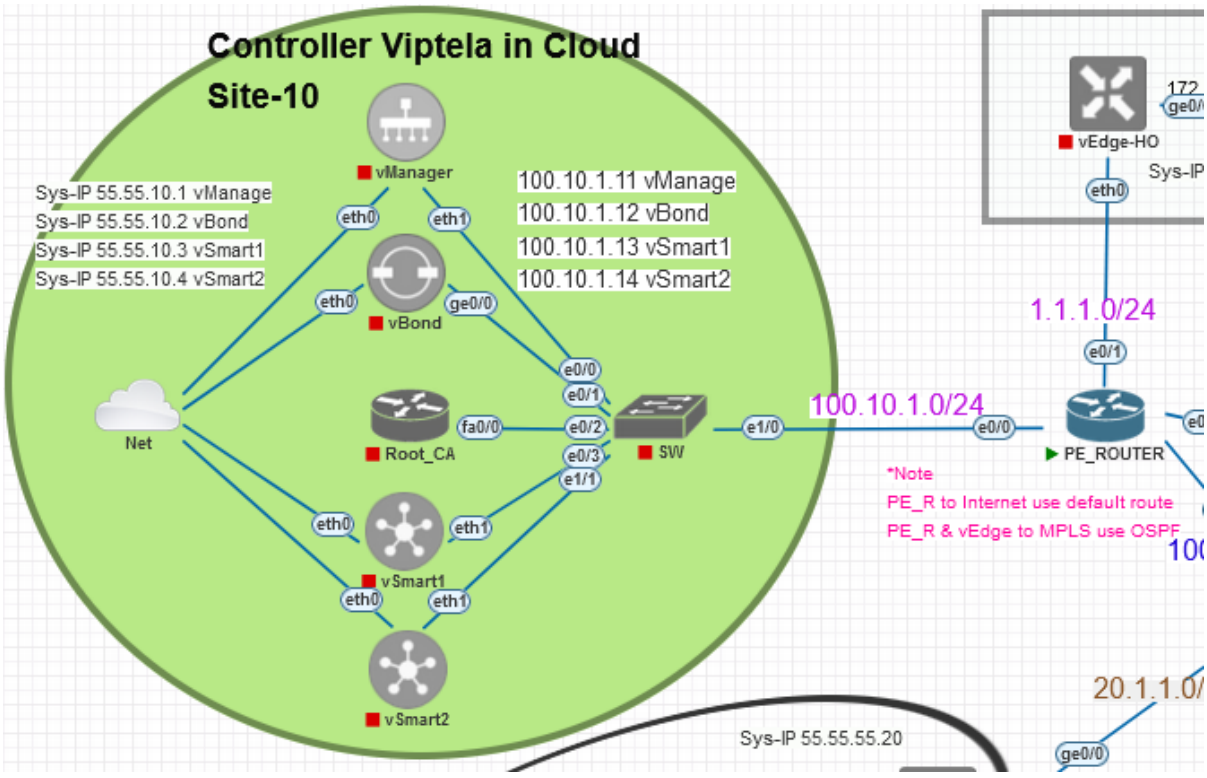
3. VPN 1 – 511 (Service VPN)
   - Enables traffic isolation similar to VRF.

- Connects LAN networks to the SD-WAN overlay and carries customer traffic to destinations via IPSec tunnels.
- Enables independent QoS, ACL, and firewall policies for each VPN.

4. VPN 513 – 65530 (User-defined VPN)
   - Functions like VPN 1–511.
   - Used for additional segmentation or specific applications requiring isolation or special network connections (e.g., IoT, Hybrid Cloud, or Multi-Tenancy).

Configuration:

vBond, vSmart, & vManage



vBond

```
system
 host-name vBond
 system-ip 55.55.10.2
 site-id 10
 organization-name MRC
 clock timezone Asia/Jakarta
 vbond 100.10.1.12 local

vpn 0
 interface ge0/0
  ip address 100.10.1.12/24
  tunnel-interface
   encapsulation ipsec
   allow-service all
   allow-service sshd
   allow-service netconf
  !
  no shutdown
 !
 ip route 0.0.0.0/0 100.10.1.10
!
vpn 512
 interface eth0
  ip dhcp-client
  ipv6 dhcp-client
  no shutdown
 !
commit
```

vSmart

```
// vSmart 1
system
 host-name vSmart1
 system-ip 55.55.10.3
 site-id 10
 organization-name MRC
 clock timezone Asia/Jakarta
 vbond 100.10.1.12

vpn 0
 interface eth1
  ip address 100.10.1.13/24
  tunnel-interface
   allow-service all
   allow-service sshd
   allow-service netconf
  !
  no shutdown
 !
 ip route 0.0.0.0/0 100.10.1.10
!
vpn 512
 interface eth0
  ip dhcp-client
  ipv6 dhcp-client
  no shutdown
 !
commit
```

```
// vSmart 2
system
 host-name vSmart2
 system-ip 55.55.10.4
 site-id 10
 organization-name MRC
 clock timezone Asia/Jakarta
 vbond 100.10.1.12

vpn 0
 interface eth1
  ip address 100.10.1.14/24
  tunnel-interface
   allow-service all
   allow-service sshd
   allow-service netconf
  !
  no shutdown
 !
 ip route 0.0.0.0/0 100.10.1.10
!
vpn 512
 interface eth0
  ip dhcp-client
  ipv6 dhcp-client
  no shutdown
!
commit
```

vManage

```
system
 host-name vmanage
 system-ip 55.55.10.1
 site-id 10
 organization-name mrc
 clock timezone asia/jakarta
 vbond 100.10.1.12

vpn 0
 interface eth1
  ip address 100.10.1.11/24
  tunnel-interface
   allow-service all
   allow-service sshd
   allow-service netconf
   allow-service https
  !
  no shutdown
 !
 ip route 0.0.0.0/0 100.10.1.10
 dns 8.8.8.8
!
vpn 512
 interface eth0
  ip dhcp-client
  ipv6 dhcp-client
  no shutdown
```

ONCE THE CONFIGURATION IS COMPLETE, VMANAGE GUI CAN BE ACCESSED.

CONNECT A PC TO THE SAME SEGMENT AS VMANAGE AND ACCESS VIA A WEB BROWSER.

INSTALL CERTIFICATE & ONBOARDING SD-WAN CONTROLLER

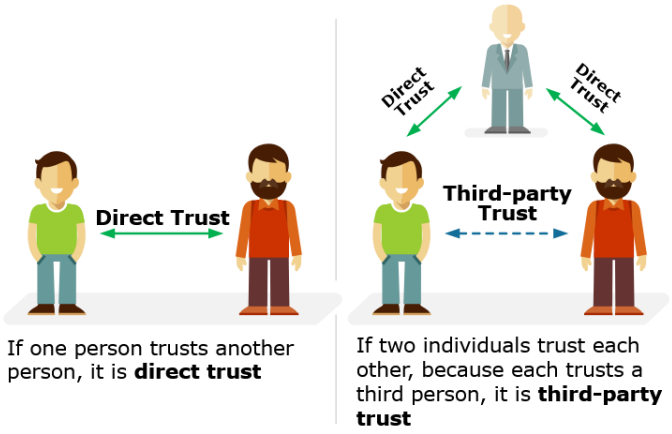
In SD-WAN, there is a process where each device must verify the digital certificates of other devices.

Why is this certificate process necessary? SD-WAN edge routers (vEdge) communicate with controllers (vManage, vBond, vSmart) using DTLS tunnels. This process is similar to TLS/SSL, requiring a handshake and involving digital certificates.

When two devices verify each other's certificates, a "trust" relationship is established (validated/authenticated). This trust can be built in two ways:

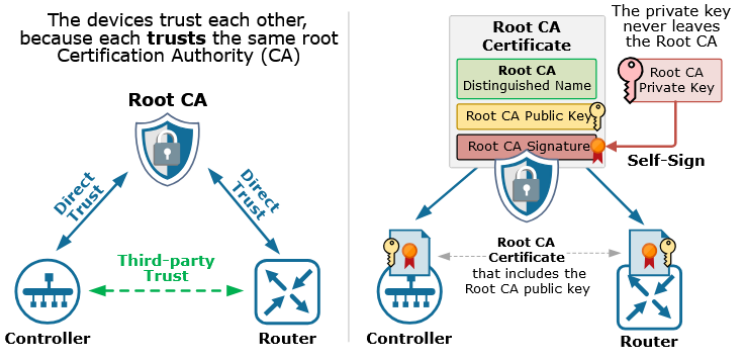
- Direct Trust: One device directly trusts another.
- Third-Party Trust: Two devices trust a third-party entity, the Certificate Authority (CA).

Due to the scalability of SD-WAN and the increasing number of WAN edges in an organization, the Direct Trust model is not feasible. Instead, SD-WAN uses the Third-Party Trust model.


Direct Trust
If one person trusts another person, it is **direct trust**
Direct Trust
Direct Trust
Third-party Trust
If two individuals trust each other, because each trusts a third person, it is **third-party trust**

Due to the vast scalability of SD-WAN and the growth of WAN Edge over time within an organization, the "Direct trust" model is not feasible. This is why SD-WAN communication uses the "Third-party trust" model. Each device will "trust" one another because they

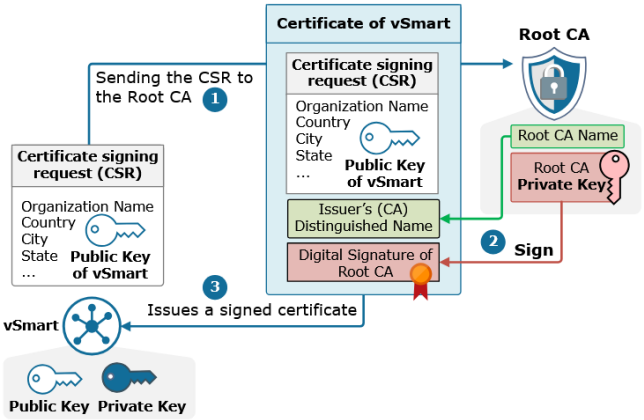
have previously trusted the same third-party entity, known as the "Certificate Authority (CA)" or "Root CA.



The Root_CA will issue a certificate, which we refer to as the root certificate. This certificate, owned by the Root_CA, needs to be installed on each device in order to identify the Root_CA as their third-party entity for establishing trust between devices. However, this process is one-sided (from the SD-WAN device to the Root_CA), and the Root_CA does not yet "trust" the SD-WAN device.

When a device wants to establish trust, it will initiate an SSL/TLS connection and also send a "Certificate Signing Request (CSR)" to the Root CA. The CSR contains information such as the device's name, organization, domain name, and so on, along with the device's public key.

Once the Root CA receives the CSR from the device, it verifies the information and signs the certificate with its private key. The Root CA then sends the signed certificate back to the requesting device as a "granted certificate." As a result, the certificate is now digitally signed, and any device with a certificate from the same Root_CA can verify the signature.



Step by step:

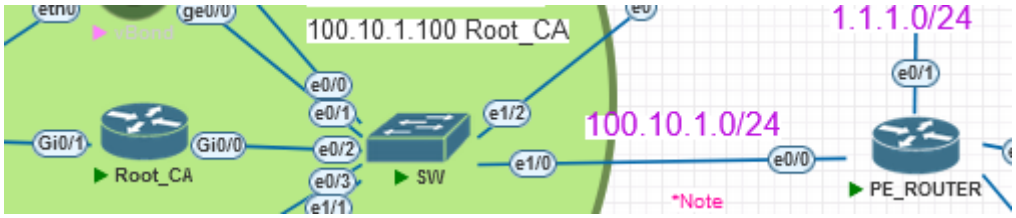


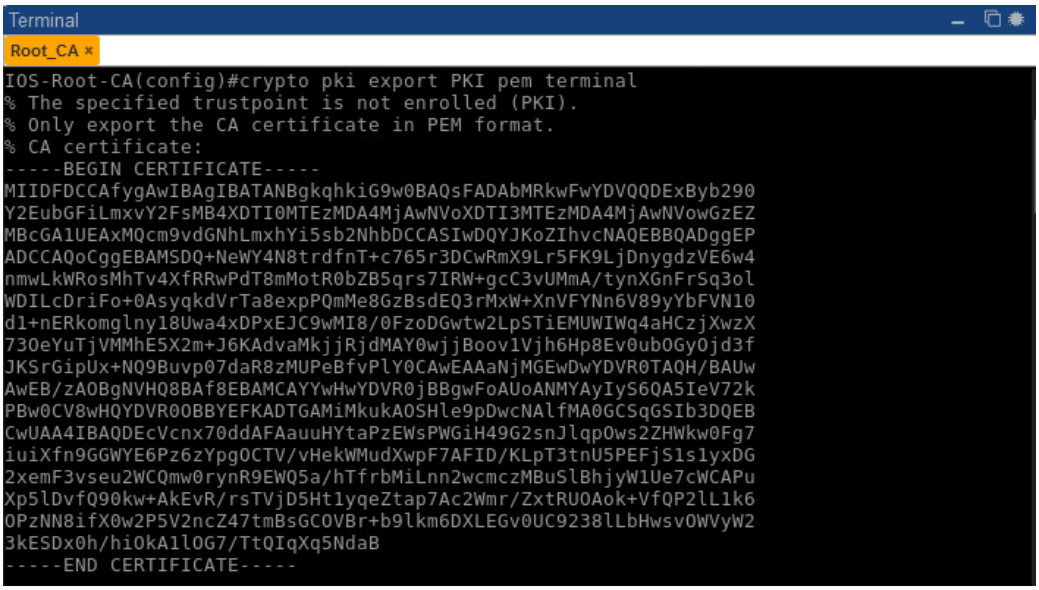
*image Root_CA: [QEMU] vios-adventerprisek9-m-15.6.2T

1. Setup Root CA

```
// Config IP dan default route
IOS-Root-CA(config)# int g0/0
IOS-Root-CA(config-if)# ip add 100.10.1.100 255.255.255.0
IOS-Root-CA(config-if)# no sh
!
IOS-Root-CA(config)# int g0/1
IOS-Root-CA(config-if)# ip add dhcp
IOS-Root-CA(config-if)# no sh
!
IOS-Root-CA(config)# ip route 0.0.0.0 0.0.0.0 100.10.1.10       << pe_router

// Create a pair of RSA public-key and private-key.
Router(config)# hostname IOS-Root-CA
IOS-Root-CA(config)# crypto key generate rsa label PKI modulus 2048
The name for the keys will be: PKI

% The key modulus size is 2048 bits
% Generating 2048 bit RSA keys, keys will be non-exportable...
[OK] (elapsed time was 6 seconds)

*Nov  6 07:49:33.179: %SSH-5-ENABLED: SSH 1.99 has been enabled


// Activate the web server for GUI access in certificate management.
IOS-Root-CA(config)#  ip http server
```

```
// Create a CA server for issuing digital certificates. The CA server functions to manage digital certificates, such as creating, signing, or revoking certificates.
IOS-Root-CA(config)# crypto pki server PKI
IOS-Root-CA(cs-server)# database url flash:
IOS-Root-CA(cs-server)# database level complete
IOS-Root-CA(cs-server)# issuer-name cn=rootca.lab.local
IOS-Root-CA(cs-server)# hash sha256
IOS-Root-CA(cs-server)# database archive pkcs12 password cisco123
IOS-Root-CA(cs-server)# grant auto
*Mar  1 00:13:16.419: %PKI-6-CS_GRANT_AUTO: All enrollment requests will be automatically granted.
IOS-Root-CA(cs-server)# no shut
%Some server settings cannot be changed after CA certificate generation.
% Certificate Server enabled.
%PKI-6-CS_ENABLED: Certificate server now enabled.

// Export the root PKI certificate of the Root-CA device to the flash directory
IOS-Root-CA(config)# crypto pki export PKI pem url flash:
% The specified trustpoint is not enrolled (PKI).
% Only export the CA certificate in PEM format.
% Exporting CA certificate...
Destination filename [PKI.ca]?
Writing file to flash:PKI.ca

// Share the PKI certificate from the Root_CA device via TFTP so that it can be downloaded by other devices
IOS-Root-CA(config)# tftp-server flash:PKI.ca
```

Briefly, the Root certificate that has been created will be used on each controller and WAN-edge device to establish 'trust'. The image below shows the form of the root certificate from the Root_CA device that has been created.



2. Setup vManage Certificate: download & install root-ca cert, generate CSR

*notes: Debug the Root_CA device to check whether the controller is initiating a TFTP request or not. If no debug output appears, use the vshell option!

Root_CA# debug tftp events/packets

// Download the root certificate via TFTP from the Root_CA device

vManage# request download tftp://100.10.1.100/PKI.ca

---------- jika tidak bisa, download lewat vshell ----------

vManage# vshell

vManage:~$ tftp -g -r PKI.ca 100.10.1.100

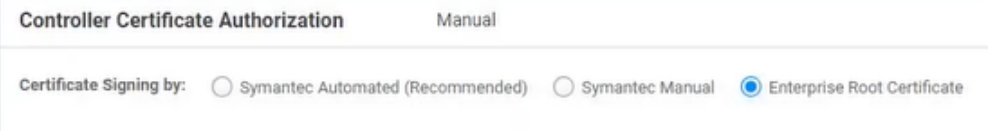
// Install the root certificate downloaded from the Root_CA on the controller.

vManage# request root-cert-chain install home/admin/PKI.ca

// Establish trust between vManage and Root_CA, import the root certificate into vManage, and prepare the CSR (Certificate Signing Request)

1. Log in to the vManage GUI.
2. In the side menu, go to Administration > Settings.

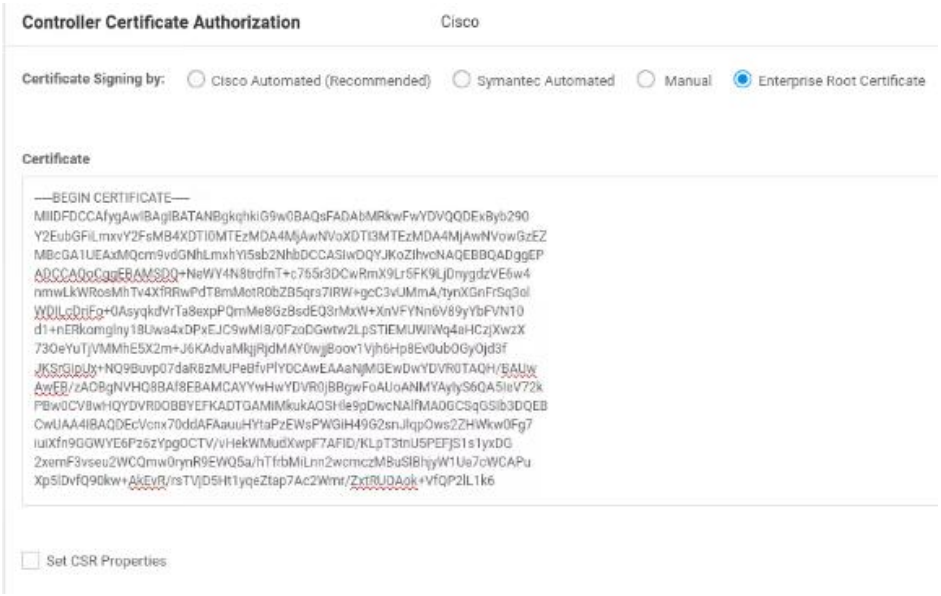
3. Edit the Organization name.
4. Specify the vBond.
5. Change 'Controller Certificate Authorization' to 'Enterprise Root Certificate'.



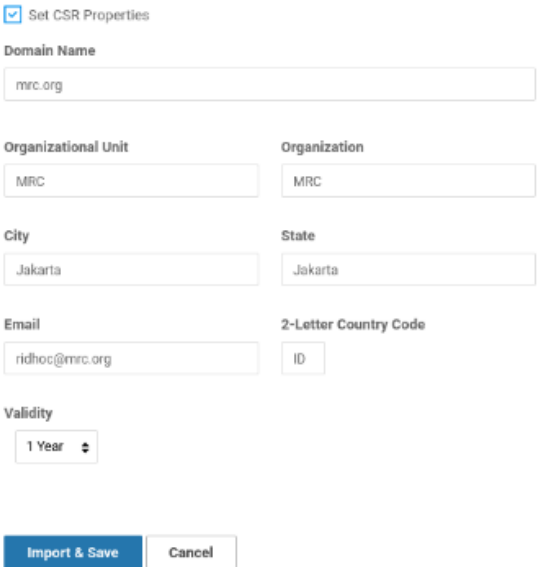
6. Manually copy the root certificate from the Root_CA device (you can use the command '**crypto pki export PKI pem terminal**')

```
IOS-Root-CA(config)#crypto pki export PKI pem terminal
% The specified trustpoint is not enrolled (PKI).
% Only export the CA certificate in PEM format.
% CA certificate:
-----BEGIN CERTIFICATE-----
MIIDFDCCAfygAwIBAgIBATANBgkqhkiG9w0BAQsFADAbMRkwFwYDVQQDExByb290
Y2EubGFiLmxvY2FsMB4XDTI0MTEzMDA4MjAwNVoXDTI3MTEzMDA4MjAwNVowGzEZ
MBcGA1UEAxMQcm9vdGNhLmxhYi5sb2NhbDCCASIwDQYJKoZIhvcNAQEBBQADggEP
ADCCAQoCggEBAMSDQ+NeWY4N8trdfnT+c765r3DCwRmX9Lr5FK9LjDnygdzVE6w4
nmwLkWRosMhTv4XfRRwPdT8mMotR0bZB5qrs7IRW+gcC3vUMmA/tynXGnFrSq3ol
WDILcDriFo+0AsyqkdVrTa8expPQmMe8GzBsdEQ3rMxW+XnVFYNn6V89yYbFVN10
d1+nERkomglny18Uwa4xDPxEJC9wMI8/0FzoDGwtw2LpSTiEMUWIWq4aHCzjXwzX
73OeYuTjVMMhE5X2m+J6KAdvaMkjjRjdMAY0wjjBoov1Vjh6Hp8Ev0ubOGyOjd3f
JKSrGipUx+NQ9Buvp07daR8zMUPeBfvPlY0CAwEAAaNjMGEwDwYDVR0TAQH/BAUw
AwEB/zAOBgNVHQ8BAf8EBAMCAYYwHwYDVR0jBBgwFoAUoANMYAyIyS6QA5IeV72k
PBw0CV8wHQYDVR0OBBYEFKADTGAMiMkukAOSHle9pDwcNAlfMA0GCSqGSIb3DQEB
CwUAA4IBAQDEcVcnx70ddAFAauuHYtaPzEWsPWGiH49G2snJlqpOws2ZHWkw0Fg7
iuiXfn9GGWYE6Pz6zYpgOCTV/vHekWMudXwpF7AFID/KLpT3tnU5PEFjS1s1yxDG
2xemF3vseu2WCQmw0rynR9EWQ5a/hTfrbMiLnn2wcmczMBuSlBhjyW1Ue7cWCAPu
Xp5lDvfQ90kw+AkEvR/rsTVjD5Ht1yqeZtap7Ac2Wmr/ZxtRUOAok+VfQP2lL1k6
OPzNN8ifX0w2P5V2ncZ47tmBsGCOVBr+b9lkm6DXLEGv0UC9238lLbHwsvOWVyW2
3kESDx0h/hiOkA1lOG7/TtQIqXq5NdaB
-----END CERTIFICATE-----
```

7. Paste the root certificate that has been copied into 'Controller Certificate Authorization



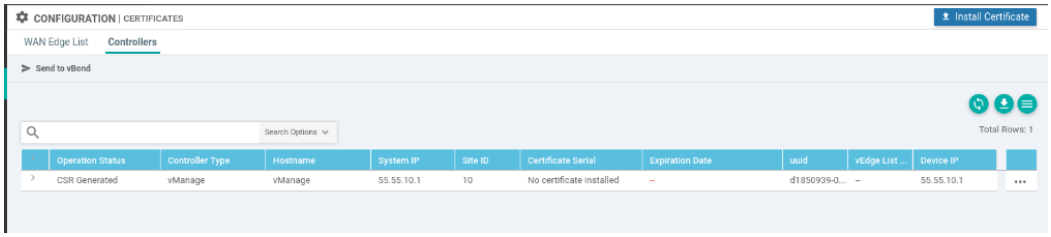
8. Check 'Set CSR Properties', then fill in the identity certificate, import, and save



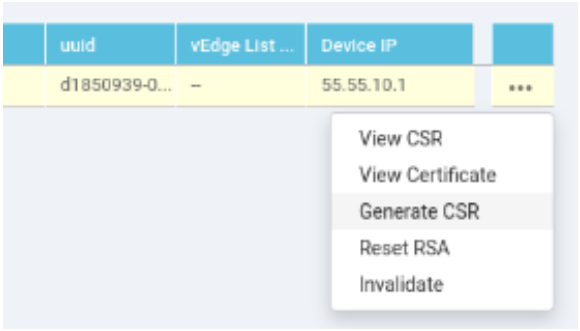
9. Thus, the CSR has been successfully created and trust has been established between vManage and Root CA.

// Generate the CSR, then request the Root_CA to sign the CSR

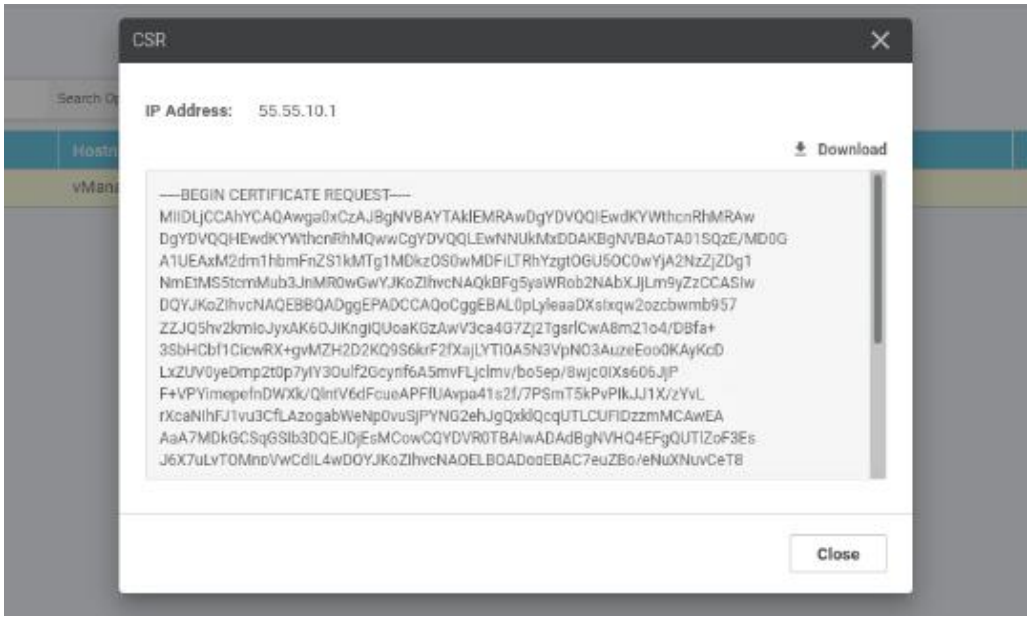
1. Go to the vManage GUI menu, Configuration > Certificate > Controllers tab



2. In the far-right menu (...), select 'Generate CSR'



3. Copy the certificate/CSR.



4. Go to the Root_CA device, then execute the following configuration:

   IOS-Root-CA# **crypto pki server PKI request pkcs10 terminal**

   *This is intended to submit a digital certificate request to the Certificate Authority (CA)

```
IOS-Root-CA#crypto pki server PKI request pkcs10 terminal
PKCS10 request in base64 or pem

% Enter Base64 encoded or PEM formatted PKCS10 enrollment request.
% End with a blank line or "quit" on a line by itself.
```

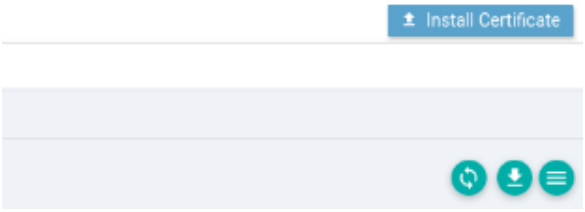
5. Paste the CSR that was copied from vManage earlier.

```
% Enter Base64 encoded or PEM formatted PKCS10 enrollment request.
% End with a blank line or "quit" on a line by itself.
-----BEGIN CERTIFICATE REQUEST-----
MIIDLjCCAhYCAQAwga0xCzAJBgNVBAYTAklEMRAwDgYDVQQIEwdKYWthcnRhMRAw
DgYDVQQHEwdKYWthcnRhMQwwCgYDVQQLEwNNUkMxDDAKBgNVBAoTA01SQzE/MD0G
A1UEAxM2dm1hbmFnZS1kMTg1MDkzOS0wMDFiLTRhYzgtOGU5OC0wYjA2NzZjZDg1
NmEtMS5tcmMub3JnMR0wGwYJKoZIhvcNAQkBFg5yaWRob2NAbXJjLm9yZzCCASIw
DQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAL0pLyleaaDXsIxqw2ozcbwmb957
ZZJQ5hv2kmIoJyxAK6OJiKngiQUoaKGzAwV3ca4G7Zj2TgsrlCwA8m21o4/DBfa+
3SbHCbf1CicwRX+gvMZH2D2KQ9S6krF2fXajLYTI0A5N3VpNO3AuzeEoo0KAyKcD
LxZUV0yeDmp2t0p7yIY3Oulf2Gcyrlf6A5mvFLjclmv/bo5ep/8wjc0IXs606JjP
F+VPYimepefnDWXk/QlntV6dFcueAPFfUAvpa41s2f/7PSmT5kPvPIkJJ1X/zYvL
rXcaNIhFJ1vu3CfLAzogabWeNp0vuSjPYNG2ehJgQxklQcqUTLCUFIDzzmMCAwEA
AaA7MDkGCSqGSIb3DQEJDjEsMCowCQYDVR0TBAIwADAdBgNVHQ4EFgQUTlZoF3Es
J6X7uLvTOMnpVwCdIL4wDQYJKoZIhvcNAQELBQADggEBAC7euZBo/eNuXNuvCeT8
2y7kIKSuNartUCL2z8R0yZNwY5F1JY2EbFbudb/LNbNXzZBAsYM28DI8YJvESSUg
eQdMLXKOjfHClk689+ToYDXCdPqOXp5At7YNY5Tnqvt4rMWhbR9OtlJN6nq4vSc1
bKroi2lOqMm54uTonfM/lptdELv+dnQp27AldtJ2pif3boGOSSfq8jOZowIEX1TR
PIlHe4Ee+6YY5YSNXAXwnPzULA2DYl4LQx/sPy8Apf4P9kq7yBevX/MTu8YtuTg2
J1qheekFZPgeU64qFrFyFHEoUkrQbpgpdiu7HfYtrE5ScZFAaYcqPcBZYwwoEKT7
QxE=
-----END CERTIFICATE REQUEST-----
```

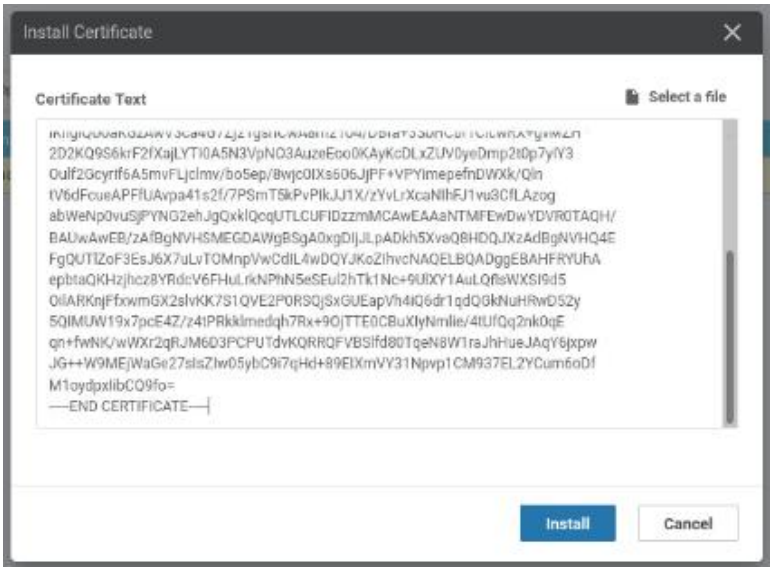
6. After that, type 'quit' and the signed certificate will be issued (granted!)

```
quit
% Granted certificate:
-----BEGIN CERTIFICATE-----
MIIDlzCCAn+gAwIBAgIBAjANBgkqhkiG9w0BAQsFADAbMRkwFwYDVQQDExByb290
Y2EubGFiLmxvY2FsMB4XDTI0MTEzMDEzMzMxN1oXDTI1MTEzMDEzMzMxN1owga0x
CzAJBgNVBAYTAklEMRAwDgYDVQQIEwdKYWthcnRhMRAwDgYDVQQHEwdKYWthcnRh
MQwwCgYDVQQLEwNNUkMxDDAKBgNVBAoTA01SQzE/MD0GA1UEAxM2dm1hbmFnZS1k
MTg1MDkzOS0wMDFiLTRhYzgtOGU5OC0wYjA2NzZjZDg1NmEtMS5tcmMub3JnMR0w
GwYJKoZIhvcNAQkBFg5yaWRob2NAbXJjLm9yZzCCASIwDQYJKoZIhvcNAQEBBQAD
ggEPADCCAQoCggEBAL0pLyleaaDXsIxqw2ozcbwmb957ZZJQ5hv2kmIoJyxAK6OJ
iKngiQUoaKGzAwV3ca4G7Zj2TgsrlCwA8m21o4/DBfa+3SbHCbf1CicwRX+gvMZH
2D2KQ9S6krF2fXajLYTI0A5N3VpNO3AuzeEoo0KAyKcDLxZUV0yeDmp2t0p7yIY3
Oulf2Gcyrif6A5mvFLjclmv/bo5ep/8wjc0IXs606JjPF+VPYimepefnDWXk/Qln
tV6dFcueAPFfUAvpa41s2f/7PSmT5kPvPIkJJ1X/zYvLrXcaNIhFJ1vu3CfLAzog
abWeNp0vuSjPYNG2ehJgQxklQcqUTLCUFIDzzmMCAwEAAaNTMFEwDwYDVR0TAQH/
BAUwAwEB/zAfBgNVHSMEGDAWgBSgA0xgDIjJLpADkh5XvaQ8HDQJXzAdBgNVHQ4E
FgQUTlZoF3EsJ6X7uLvTOMnpVwCdIL4wDQYJKoZIhvcNAQELBQADggEBAHFRYUhA
epbtaQKHzjhcz8YRdcV6FHuLrkNPhN5eSEul2hTk1Nc+9UlXY1AuLQflsWXSI9d5
OilARKnjFfxwmGX2slvKK7S1QVE2P0RSQjSxGUEapVh4iQ6dr1qdQGkNuHRwD52y
5QIMUW19x7pcE4Z/z4tPRkklmedqh7Rx+9OjTTE0CBuXIyNmlie/4tUfQq2nk0qE
qn+fwNK/wWXr2qRJM6D3PCPUTdvKQRRQFVBSlfd80TqeN8W1raJhHueJAqY6jxpw
JG++W9MEjWaGe27slsZIw05ybC9i7qHd+89EIXmVY31Npvp1CM937EL2YCum6oDf
M1oydpxIibCQ9fo=
-----END CERTIFICATE-----
```

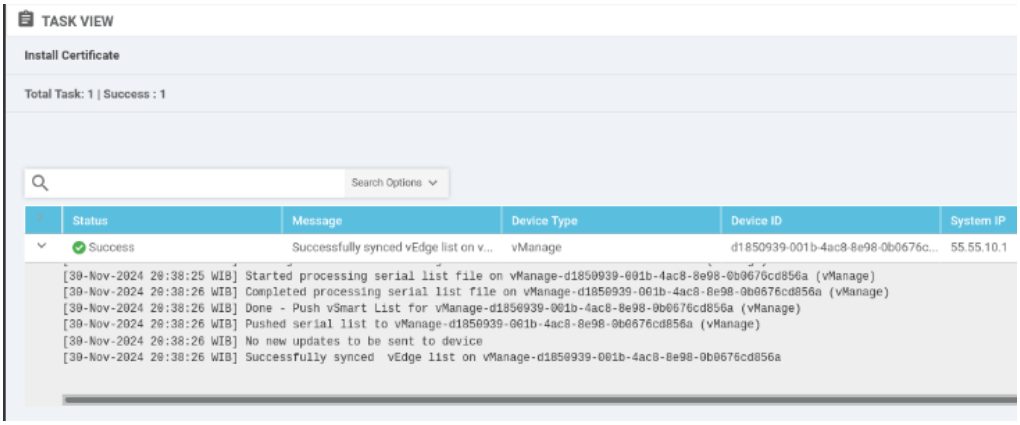
7. Copy the granted certificate, then return to the vManage GUI. In the top-right corner, click 'Install Certificate'



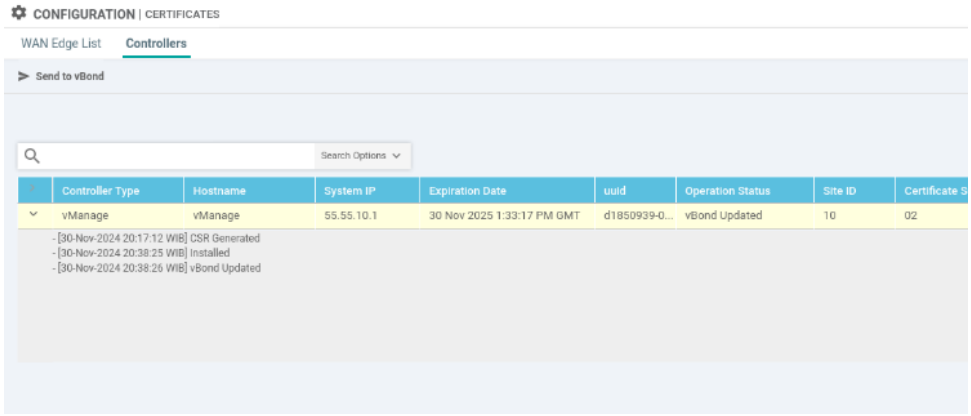
8. Finally, paste the granted certificate into the 'Install Certificate' field, then click install.



9. Wait for a moment, and the certificate will be successfully installed on vManage.


TASK VIEW
Install Certificate
Total Task: 1 | Success : 1
Search Options
Status
Message
Device Type
Device ID
System IP
Success
Successfully synced vEdge list on v...
vManage
d1850939-001b-4ac8-8e98-0b0676c...
55.55.10.1
[30-Nov-2024 20:38:25 WIB] Started processing serial list file on vManage-d1850939-001b-4ac8-8e98-0b0676cd856a (vManage)
[30-Nov-2024 20:38:26 WIB] Completed processing serial list file on vManage-d1850939-001b-4ac8-8e98-0b0676cd856a (vManage)
[30-Nov-2024 20:38:26 WIB] Done - Push vSmart List for vManage-d1850939-001b-4ac8-8e98-0b0676cd856a (vManage)
[30-Nov-2024 20:38:26 WIB] Pushed serial list to vManage-d1850939-001b-4ac8-8e98-0b0676cd856a (vManage)
[30-Nov-2024 20:38:26 WIB] No new updates to be sent to device
[30-Nov-2024 20:38:26 WIB] Successfully synced vEdge list on vManage-d1850939-001b-4ac8-8e98-0b0676cd856a

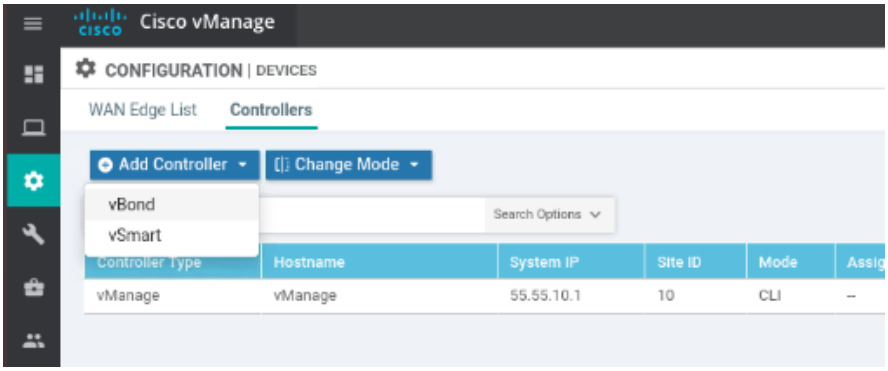
10. If we go back to Configuration > Certificate, we can see that the certificate has been successfully installed on vManage



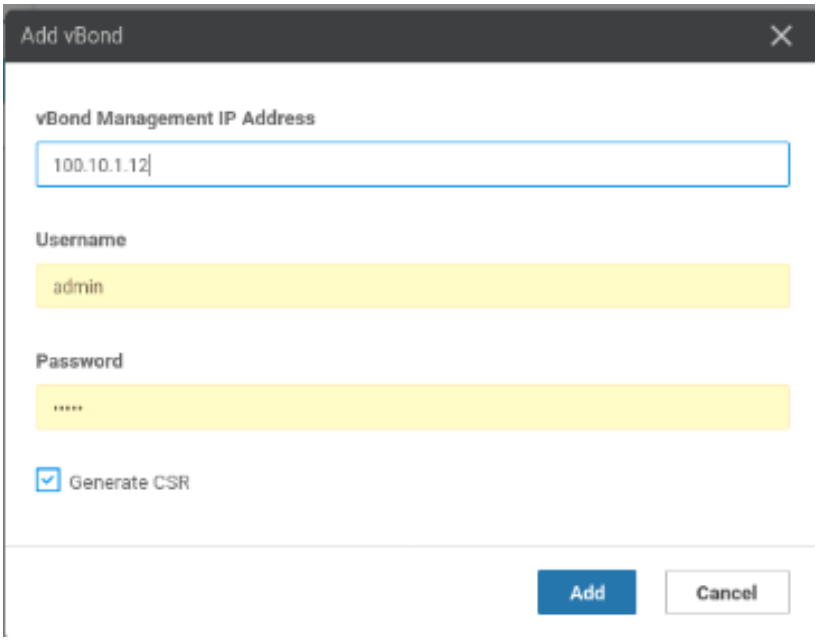
3. Setup vBond Certificate: download & install root-ca cert, generate CSR

// Add the vBond device to vManage

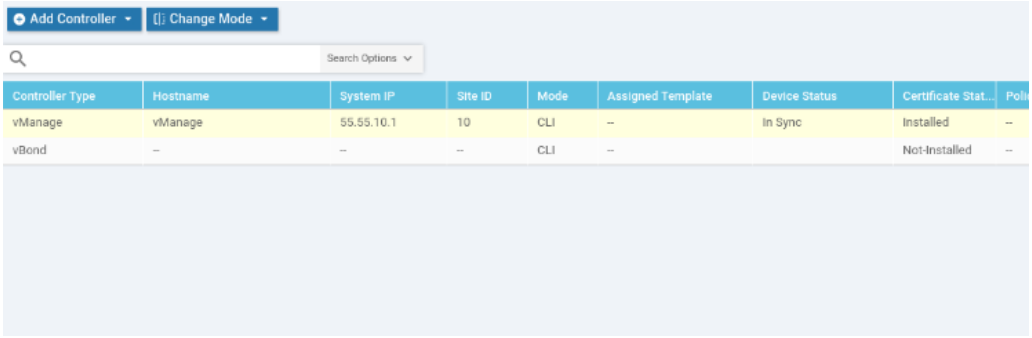
1. Go to the vManage GUI, Configuration > Device > Controller, then click 'Add Controller' and select vBond.



2. Enter the vBond IP address along with its username and password, then check 'Generate CSR'.



3. Thus, the vBond device has been added to vManage



// Download the root certificate via TFTP from the Root_CA device

vBond# request download tftp://100.10.1.100/PKI.ca

---------- If it is not possible, download via vshell ----------

vBond# vshell

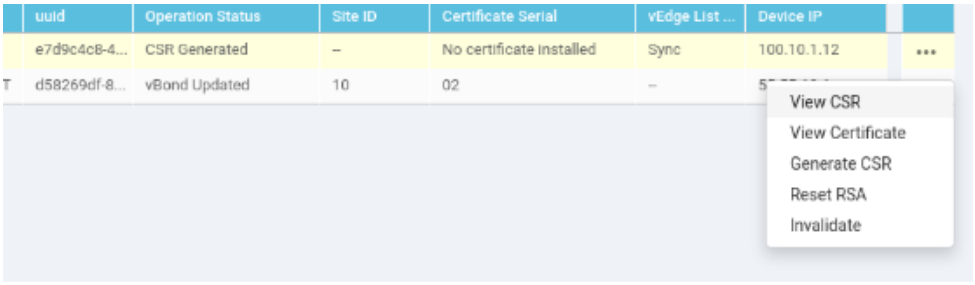
vBond:~$ tftp -g -r PKI.ca 100.10.1.100

// Install the root certificate downloaded from the Root_CA on the controller

vBond# request root-cert-chain install home/admin/PKI.ca

// Generate the CSR, then request the Root_CA to sign the CSR

1. Go to Configuration > Certificate, then under vBond, you can see 'CSR Generated'. Select 'View CSR'



2. Copy the CSR from the vBond.

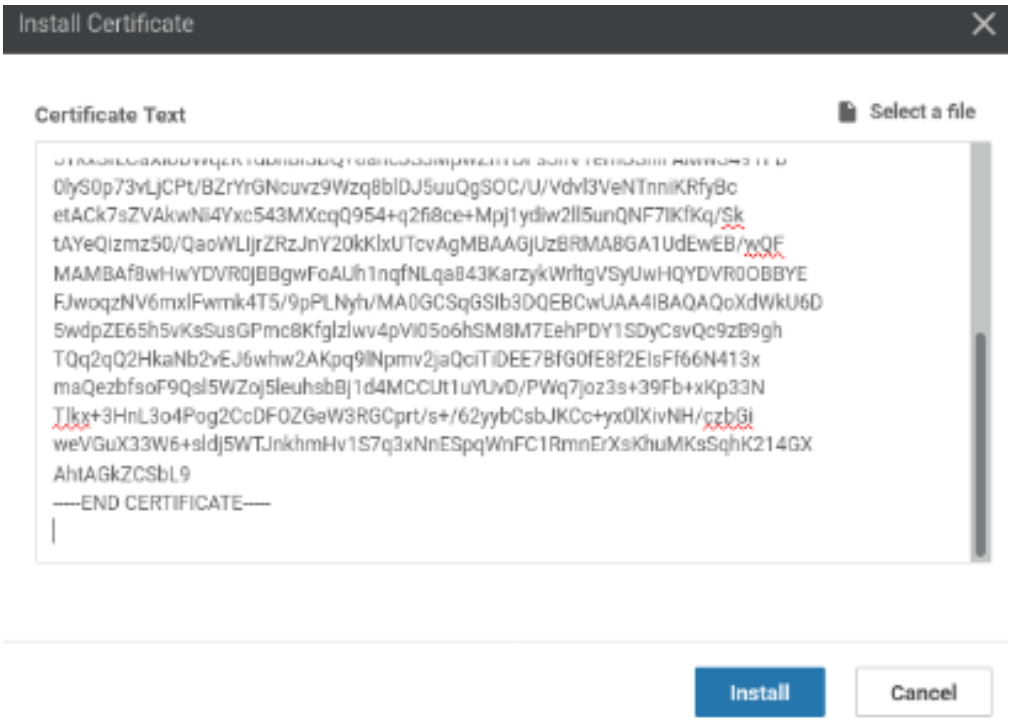
3. Return to the Root_CA device, then use the command 'crypto pki server PKI request pkcs10 pem terminal', and paste the CSR from the vBond that was copied.

```
IOS-Root-CA#crypto pki server PKI request pkcs10 terminal
PKCS10 request in base64 or pem

% Enter Base64 encoded or PEM formatted PKCS10 enrollment request.
% End with a blank line or "quit" on a line by itself.
-----BEGIN CERTIFICATE REQUEST-----
MIIDLDCCAhQCAQAwgasxCzAJBgNVBAYTAklEMRAwDgYDVQQIEwdKYWthcnRhMRAw
DgYDVQQHEwdKYWthcnRhMQwwCgYDVQQLEwNNUkMxDDAKBgNVBAoTA01SQzE9MDsG
A1UEAxM0dmJvbmQtZTdkOWM0YzgtNDRlNS00OWVjLWIxYWMtY2U2ZGZkOWU5NWE4
LTAubXJjLm9yZzEdMBsGCSqGSIb3DQEJARYOcmlkaG9jQG1yYy5vcmcwggEiMA0G
CSqGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQC/kH0/2TYLuA9hY6s8WORWm928Tgxg
7o0+XuK9JrML3woL3wEmodys/z9pydfrUapYpQ89IUFmOfnkTzxAVqZ64YhFzzCN
zy34IHukr2dx/JyL+m3e5YkxSfLCaXloDWqzK1dbnBlSDQ+8ahcJS3MpwZhTDFs5
nV1ernUShlFAMwS49TFD0lyS0p73vLjCPt/BZrYrGNcuvz9Wzq8blDJSuuQgSOC/
U/Vdvl3VeNTnniKRfyBcetACk7sZVAkwNi4Yxc543MXcqQ954+q2fi8ce+Mpj1yd
iw2ll5unQNF7IKfKq/SktAYeQizmz50/QaoWLIjrZRzJnY20kKlxUTcvAgMBAAGg
OzA5BgkqhkiG9w0BCQ4xLDAqMAkGA1UdEwQCMAAwHQYDVR0OBBYEFJwoqzNV6mxl
Fwmk4T5/9pPLNyh/MA0GCSqGSIb3DQEBCwUAA4IBAQB+dgLEsa+HsJ3VyZDeFxlc
Es1se8jeGdNwD3QJD/pry7hOf/XMEgBN/ptel5RlWjKwj01wbvSLVagHeYeZMFk0
8xgdruLqoatSPImBOdTNRmpFpLbAftq0mv9h6t2vaFKHMUImbeN4w2jaxLoFs9zf
+NTeENPe+tHE3be2Jii/a8WZx8dl9HNKCVWabzVHoD8eIu7AVmVscI6U320w6/Rn
iX3br8e5yH70PK4XDZiPDvKm7j8fq610IUOz1x3D50QkAfbclncvOb8GM9qfu/m+
pV2xtgxKK115kYrzQjHYeO3Eo0W96hzWvv7AkPny5fH8YQbS75gv5vYXVKazs75B
-----END CERTIFICATE REQUEST-----
```

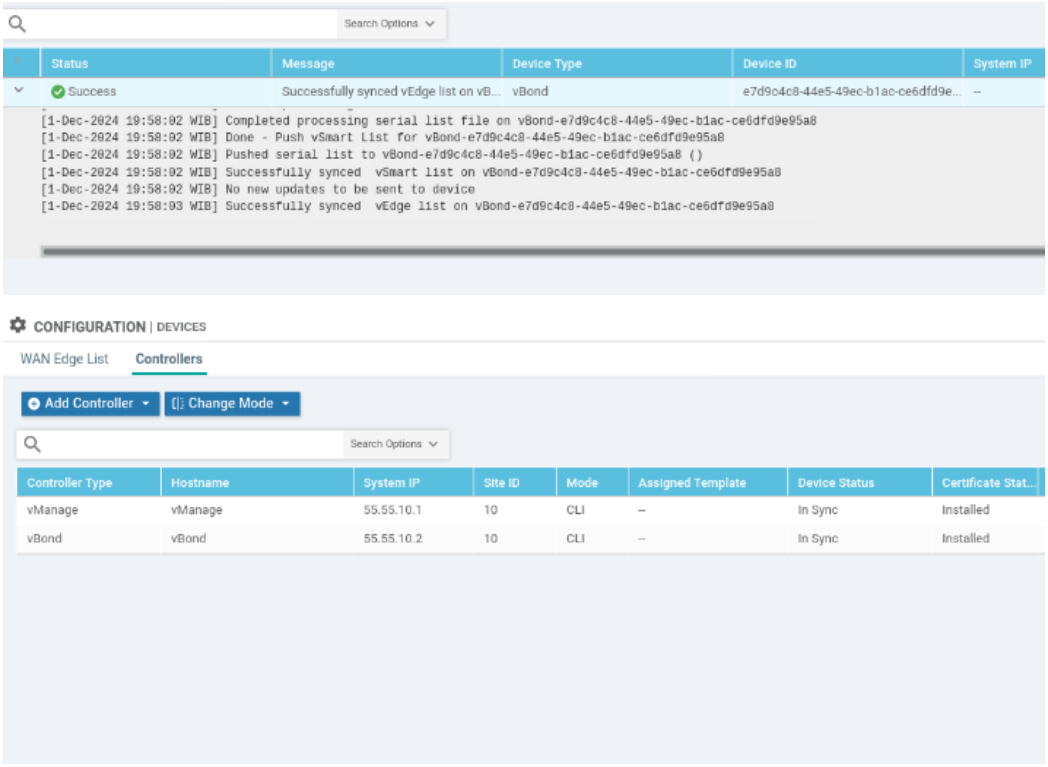
4. Type 'quit', then the granted certificate will be issued by the Root_CA. Copy the granted certificate.

```
-----END CERTIFICATE REQUEST-----
quit
% Granted certificate:
-----BEGIN CERTIFICATE-----
MIIDlTCCAn2gAwIBAgIBAzANBgkqhkiG9w0BAQsFADAbMRkwFwYDVQQDExByb290
Y2EubGFiLmxvY2FsMB4XDTI0MTIwMTEyNTQ0NFoXDTI1MTIwMTEyNTQ0NFowgasx
CzAJBgNVBAYTAklEMRAwDgYDVQQIEwdKYWthcnRhMRAwDgYDVQQHEwdKYWthcnRh
MQwwCgYDVQQLEwNNUkMxDDAKBgNVBAoTA01SQzE9MDsGA1UEAxM0dmJvbmQtZTdk
OWM0YzgtNDRlNS00OWVjLWIxYWMtY2U2ZGZkOWU5NWE4LTAubXJjLm9yZzEdMBsG
CSqGSIb3DQEJARYOcmlkaG9jQG1yYy5vcmcwggEiMA0GCSqGSIb3DQEBAQUAA4IB
DwAwggEKAoIBAQC/kH0/2TYLuA9hY6s8WORWm928Tgxg7o0+XuK9JrML3woL3wEm
ody s/z9pydfrUapYpQ89IUFmOfnkTzxAVqZ64YhFzzCNzy34IHukr2dx/JyL+m3e
5YkxSfLCaXloDWqzK1dbnBiSDQ+BahcJS3MpwZhTDFs5nV1ernUShlFAMwS49TFD
0lyS0p73vLjCPt/BZrYrGNcuvz9Wzq8blDJ5uuQgSOC/U/Vdvl3VeNTnnlKRfyBc
etACk7sZVAkwNi4Yxc543MXcqQ954+q2fi8ce+Mpj1ydiw2ll5unQNF7IKfKq/Sk
tAYeQizmz50/QaoWLIjrZRzJnY20kKlxUTcvAgMBAAGjUzBRMA8GA1UdEwEB/wQF
MAMBAf8wHwYDVR0jBBgwFoAUh1nqfNLqa843KarzykWrltgVSyUwHQYDVR0OBBYE
FJwoqzNV6mxlFwmk4T5/9pPLNyh/MA0GCSqGSIb3DQEBCwUAA4IBAQAQoXdWkU6D
5wdpZE65h5vKsSusGPmc8Kfglzlwv4pVi05o6hSM8M7EehPDY1SDyCsvQc9zB9gh
TQq2qQ2HkaNb2vEJ6whw2AKpq9lNpmv2jaQciTlDEE7BfG0fE8f2EIsFf66N413x
maQezbfsoF9Qsl5WZoj5leuhsbBj1d4MCCUt1uYUvD/PWq7joz3s+39Fb+xKp33N
Tlkx+3HnL3o4Pog2CcDFOZGeW3RGCprt/s+/62yybCsbJKCc+yx0lXivNH/czbGi
weVGuX33W6+sldj5WTJnkhmHv1S7q3xNnESpqWnFC1RmnErXsKhuMKsSqhK214GX
AhtAGkZCSbL9
-----END CERTIFICATE-----
```

5. Go back to the vManage GUI, then in the top-right corner, click 'Install Certificate', paste the granted certificate that was copied, and then click 'Install'



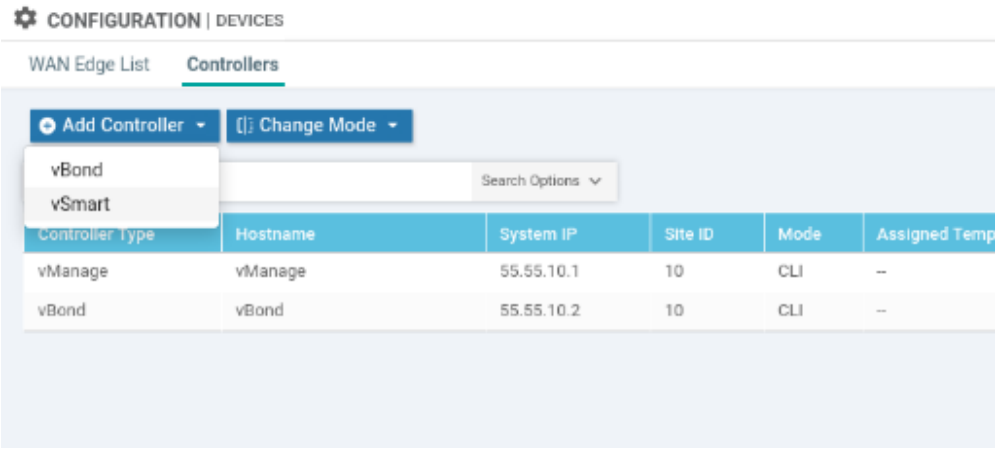
6. Thus, the vBond device has been successfully installed on vManage or successfully onboarded



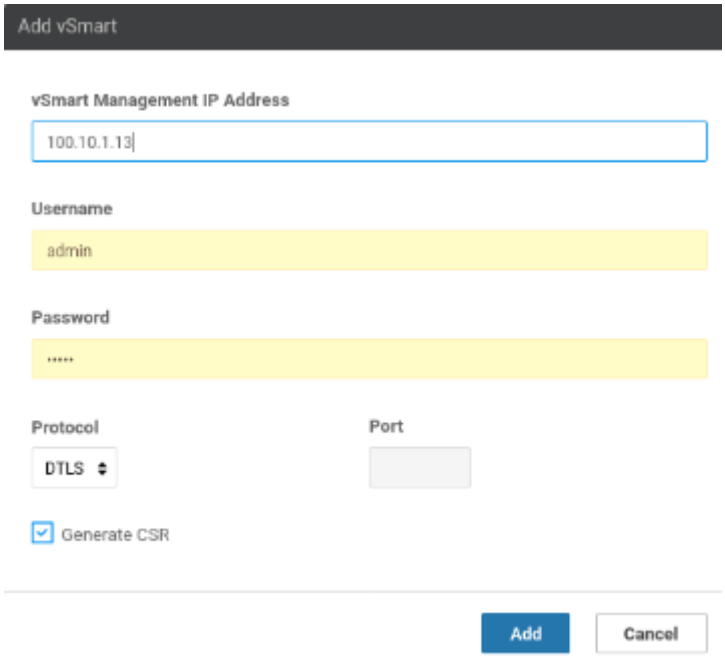
4. Setup vSmart Certificate: download & install root-ca cert, generate CSR

// Add the vSmart1 device to vManage

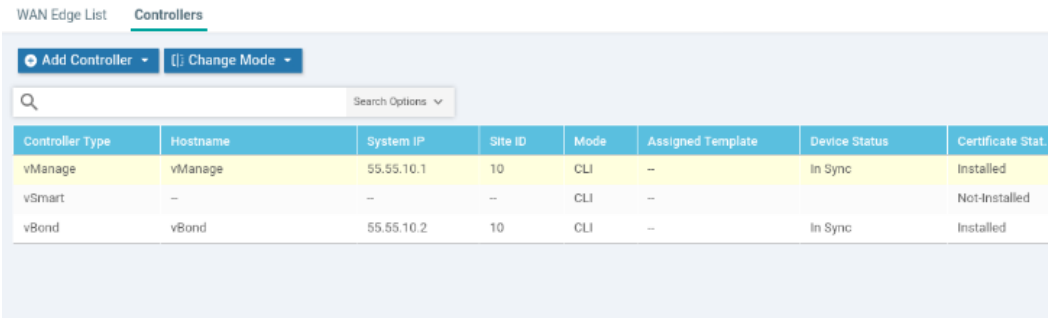
1. Go to the vManage GUI, Configuration > Device > Controller, then click 'Add Controller' and select vSmart.



2. Enter the vSmart1 IP address along with its username and password, then check 'Generate CSR'. Leave the protocol and port as default.



3. Thus, the vSmart device has been added to vManage.



// Download the root certificate via TFTP from the Root_CA device

vSmart1# request download tftp://100.10.1.100/PKI.ca

---------- If it is not possible, download via vshell ----------

vSmart1# vshell

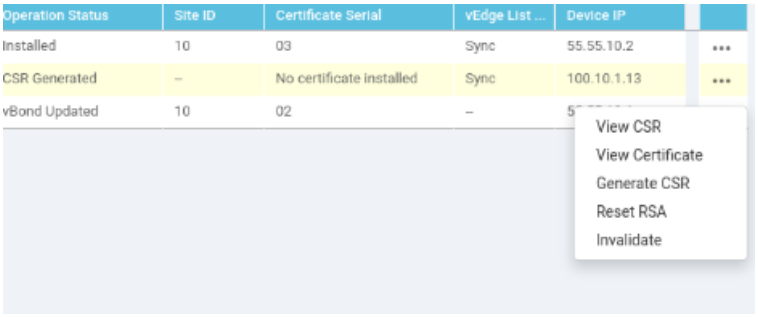
vSmart1:~$ tftp -g -r PKI.ca 100.10.1.100

// Install the root certificate downloaded from the Root_CA on the controller.

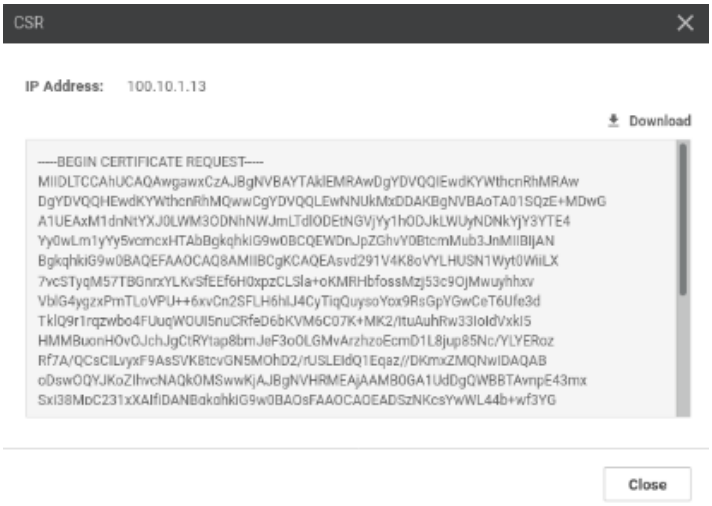
vSmart1# request root-cert-chain install home/admin/PKI.ca

// Generate the CSR, then request the Root_CA to sign the CSR

1. Go to Configuration > Certificate, then under vSmart1, you can see 'CSR Generated'. Select 'View CSR'



2. Copy the CSR from vSmart1.



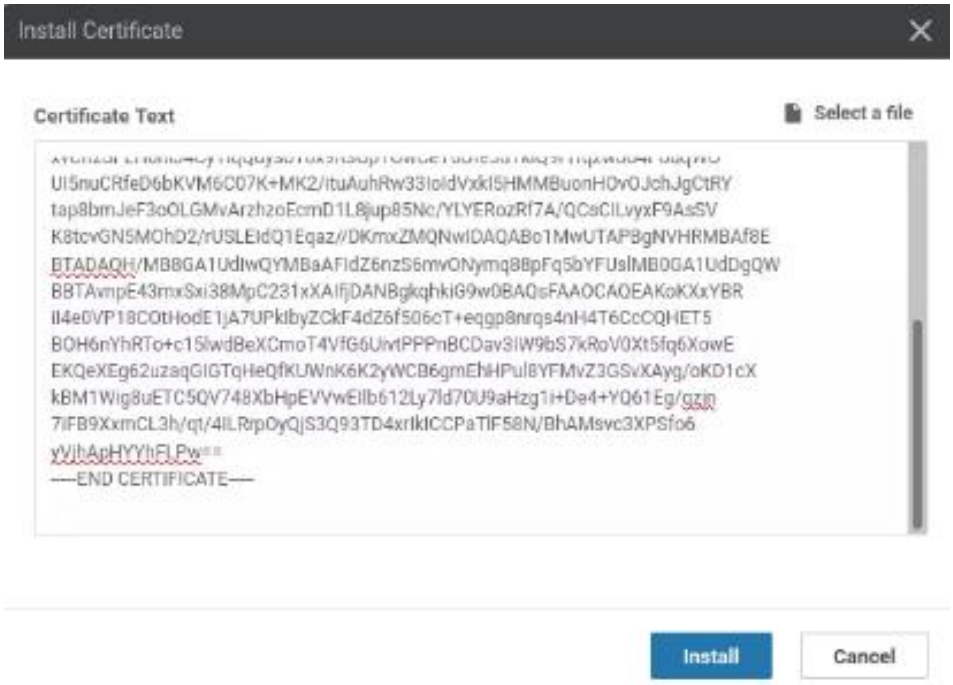
3. Return to the Root_CA device, then execute the command 'crypto pki server PKI request pkcs10 pem terminal', and paste the CSR from vSmart1 that was copied.

```
IOS-Root-CA#crypto pki server PKI request pkcs10 terminal
PKCS10 request in base64 or pem

% Enter Base64 encoded or PEM formatted PKCS10 enrollment request.
% End with a blank line or "quit" on a line by itself.
-----BEGIN CERTIFICATE REQUEST-----
MIIDLTCCAhUCAQAwgawxCzAJBgNVBAYTAklEMRAwDgYDVQQIEwdKYWthcnRhMRAw
DgYDVQQHEwdKYWthcnRhMQwwCgYDVQQLEwNNUkMxDDAKBgNVBAoTA01SQzE+MDwG
A1UEAxM1dnNtYXJ0LWM3ODNhNWJmLTdlODEtNGVjYy1hODJkLWUyNDNkYjY3YTE4
Yy0wLm1yYy5vcmcxHTAbBgkqhkiG9w0BCQEWDnJpZGhvY0BtcmHub3JnMIIBIjAN
BgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAsvd291V4K8oVYLHUSN1Wyt0WiiLX
7vcSTyqM57TBGnrxYLKvSfEEf6H0xpzCLSla+oKMRHbfossMzj53c9OjMwuyhhxv
VblG4ygzxPmTLoVPU++6xvCn2SFLH6hIJ4CyTiqQuysoYox9RsGpYGwCeT6Ufe3d
TklQ9r1rqzwbo4FUuqWOUI5nuCRfeD6bKVM6C07K+MK2/ltuAuhRw33IoIdVxkI5
HMMBuonHOvOJchJgCtRYtap8bmJeF3oOLGMvArzhzoEcmD1L8jup85Nc/YLYERoz
Rf7A/QCsCILvyxF9AsSVK8tcvGN5MOhD2/rUSLEIdQ1Eqaz//DKmxZMQNwIDAQAB
oDswOQYJKoZIhvcNAQkOMSwwKjAJBgNVHRMEAjAAMB0GA1UdDgQWBBTAvnpE43mx
Sxl38MpC231xXAIfjDANBgkqhkiG9w0BAQsFAAOCAQEADSzNKcsYwWL44b+wf3YG
EL8oAqEPTRpHruk3Th0MQ1sP9g28qtL3oB4JZjHq9+NY+98cgsoZlaZsWI1Soxak
VsbGcldN7d/4+54AtM1wKJSgj/aaTHnBtlkHgeMsKeZbRVc3aL1WhzBPY2dzXfp6
GqYodVT3Q4o+CbkB3trg0T6VymEZNNpWgLC+qwMpo6O/PoTgM50ANOT0NB3koxem
d/UMUQpjxbvcFvI+a60Fyl918qbmImZq5ngCbYUKYjl6LG61oDsugs8ZQlH3KJ1l
I/62ih5lDgH0dAEHHF9BEcBYa/P6n//Llo/jjg3KVP3m7Rmz1dtmBBOSmSZqyrrc
wQ==
-----END CERTIFICATE REQUEST-----
```

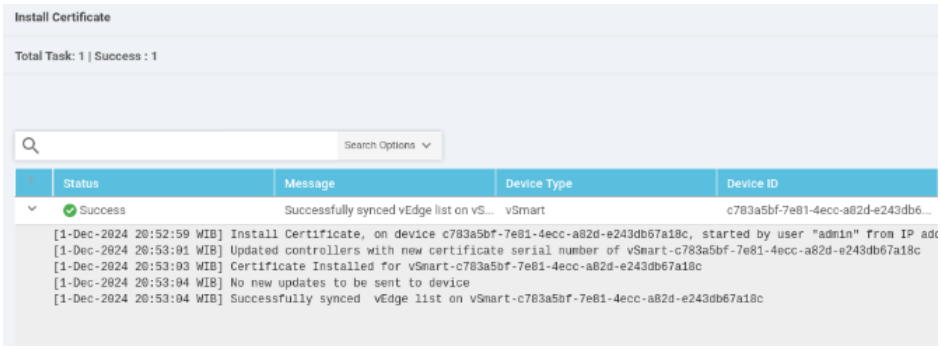
4. Type 'quit', then the granted certificate will be issued by the Root_CA. Copy the granted certificate.

```
quit
% Granted certificate:
-----BEGIN CERTIFICATE-----
MIIDljCCAn6gAwIBAgIBBDANBgkqhkiG9w0BAQsFADAbMRkwFwYDVQQDExByb290
Y2EubGFiLmxvY2FsMB4XDTI0MTIwMTEzNTAzMloXDTI1MTIwMTEzNTAzMlowgawx
CzAJBgNVBAYTAklEMRAwDgYDVQQIEwdKYWthcnRhMRAwDgYDVQQHEwdKYWthcnRh
MQwwCgYDVQQLEwNNUkMxDDAKBgNVBAoTA01SQzE+MDwGA1UEAxM1dnNtYXJ0LWM3
ODNhNWJmLTdlODEtNGVjYy1hODJkLWUyNDNkYjY3YTE4Yy0wLm1yYy5vcmcxHTAb
BgkqhkiG9w0BCQEWDnJpZGhvY0BtcmMub3JnMIIBIjANBgkqhkiG9w0BAQEFAAOC
AQ8AMIIBCgKCAQEAsvd291V4K8oVYLHUSN1Wyt0WiiLX7vcSTyqM57TBGnrxYLKv
SfEEf6H0xpzCLSla+oKMRHbfossMzj53c9OjMwuyhhxvVblG4ygzxPmTLoVPU++6
xvCn2SFLH6hIJ4CyTiqQuysoYox9RsGpYGwCeT6Ufe3dTklQ9r1rqzwbo4FUuqWO
UI5nuCRfeD6bKVM6C07K+MK2/ituAuhRw33IoIdVxkI5HMMBuonHOvOJchJgCtRY
tap8bmJeF3oOLGMvArzhzoEcmD1L8jup85Nc/YLYERozRf7A/QCsCILvyxF9AsSV
K8tcvGN5MOhD2/rUSLEIdQ1Eqaz//DKmxZMQNwIDAQABo1MwUTAPBgNVHRMBAf8E
BTADAQH/MB8GA1UdIwQYMBaAFIdZ6nzS6mvONymq88pFq5bYFUslMB0GA1UdDgQW
BBTAvnpE43mxSxi38MpC231xXAIfjDANBgkqhkiG9w0BAQsFAAOCAQEAKoKXxYBR
lI4e0VP18COtHodE1jA7UPkIbyZCkF4dZ6f506cT+eqgp8nrqs4nH4T6CcCQHET5
BOH6nYhRTo+c15lwdBeXCmoT4VfG6UlvtPPPnBCDav3IW9bS7kRoV0Xt5fq6XowE
EKQeXEg62uzaqGIGTqHeQfKUWnK6K2yWCB6gmEhHPul8YFMvZ3GSvXAyg/oKD1cX
kBM1Wig8uETC5QV748XbHpEVVwEIlb612Ly7ld70U9aHzg1i+De4+YQ61Eg/qzjn
7iFB9XxmCL3h/qt/4ILRrpOyQjS3Q93TD4xrIkICCPaTlF58N/BhAMsvc3XPSfo6
yVjhApHYYhFLPw==
-----END CERTIFICATE-----
```

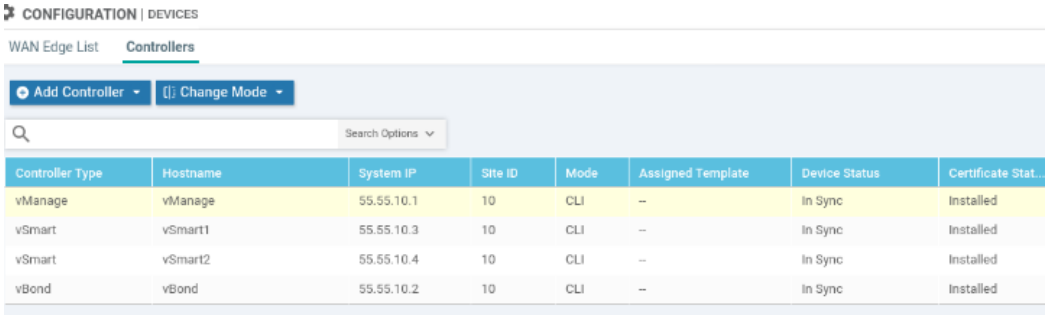
5. Go back to the vManage GUI, then in the top-right corner, click 'Install Certificate', paste the granted certificate that was copied, and then click 'Install'



6. Thus, the vSmart device has been successfully installed on vManage or successfully onboarded


Install Certificate
Total Task: 1 | Success : 1
Search Options
Status
Message
Device Type
Device ID
Success
Successfully synced vEdge list on vS...
vSmart
c783a5bf-7e81-4ecc-a82d-e243db6...
[1-Dec-2024 20:52:59 WIB] Install Certificate, on device c783a5bf-7e81-4ecc-a82d-e243db67a18c, started by user "admin" from IP ad
[1-Dec-2024 20:53:01 WIB] Updated controllers with new certificate serial number of vSmart-c783a5bf-7e81-4ecc-a82d-e243db67a18c
[1-Dec-2024 20:53:03 WIB] Certificate Installed for vSmart-c783a5bf-7e81-4ecc-a82d-e243db67a18c
[1-Dec-2024 20:53:04 WIB] No new updates to be sent to device
[1-Dec-2024 20:53:04 WIB] Successfully synced vEdge list on vSmart-c783a5bf-7e81-4ecc-a82d-e243db67a18c

7. **DO THE SAME FOR VSMART2**
8. Thus, all controllers have successfully gone 'In sync' or been onboarded with vManage.



5. **Verify the onboarded controller.**

// vManage & vSmart

vManage/vSmart# show control connections

```
      PEER    PEER PEER            CONFIGURED        SITE       DOMAIN PEER
INDEX TYPE    PROT SYSTEM IP       SYSTEM IP       ID         ID     PRIVATE IP
ATION            REMOTE COLOR     STATE UPTIME
-------------------------------------------------------------------------------
-------------------------------------------------
0     vsmart  dtls 55.55.10.3      55.55.10.3      10         1      100.10.1.13
                 default          up     0:00:17:32
0     vsmart  dtls 55.55.10.4      55.55.10.4      10         1      100.10.1.14
                 default          up     0:00:10:17
0     vbond   dtls 55.55.10.2      55.55.10.2      0          0      100.10.1.12
                 default          up     0:01:12:33
1     vbond   dtls 0.0.0.0         -               0          0      100.10.1.12
                 default          up     0:01:12:33
2     vbond   dtls 0.0.0.0         -               0          0      100.10.1.12
                 default          up     0:01:12:35
3     vbond   dtls 0.0.0.0         -               0          0      100.10.1.12
                 default          up     0:01:12:35
```

// vBond

vBond# show orchestrator connections

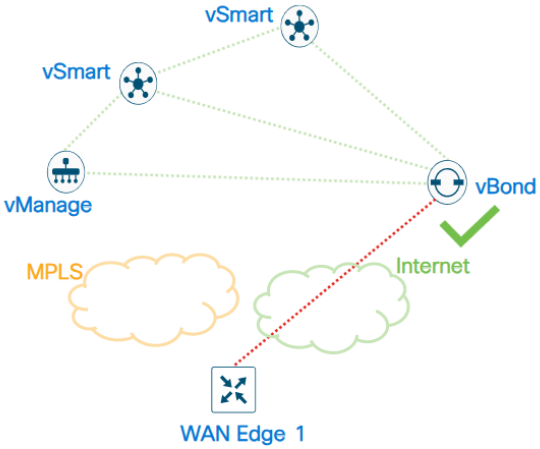
```
                PEER     PEER     PEER            SITE       DOMAIN     PEER
INSTANCE TYPE           PROTOCOL SYSTEM IP       ID         ID         PRIVATE IP
        UPTIME
------------------------------------------------------------------------------
----------------------
0        vsmart   dtls     55.55.10.3      10         1          100.10.1.13
        0:00:12:16
0        vsmart   dtls     55.55.10.3      10         1          100.10.1.13
        0:00:12:16
0        vsmart   dtls     55.55.10.4      10         1          100.10.1.14
        0:00:05:13
0        vsmart   dtls     55.55.10.4      10         1          100.10.1.14
        0:00:05:13
0        vmanage  dtls     55.55.10.1      10         0          100.10.1.11
        0:01:07:16
0        vmanage  dtls     55.55.10.1      10         0          100.10.1.11
        0:01:07:16
0        vmanage  dtls     55.55.10.1      10         0          100.10.1.11
        0:01:07:16
0        vmanage  dtls     55.55.10.1      10         0          100.10.1.11
        0:01:07:16
```

INSTALL CERTIFICATE & ONBOARDING SD-WAN EDGE / VEDGE

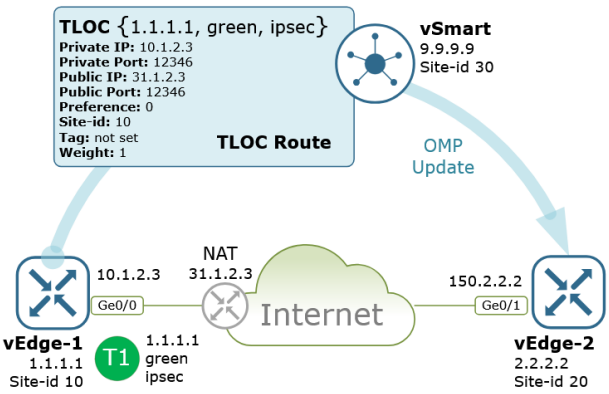
Via Public Internet

In this scenario, we will use two transport links, namely Internet and MPLS, to interconnect the vEdge to the controllers. The vEdge automatically establishes a DTLS tunnel to the vSmart and forms an OMP neighborship to exchange routing information.

During the onboarding process of the vEdge device to the controller, the vEdge device sends the 'Transport Locator (TLOC)' to the vBond (Orchestrator) when the device joins the SD-WAN fabric.



TLOC is a unique identifier used to identify the transport link that connects the vEdge device to the SD-WAN fabric.



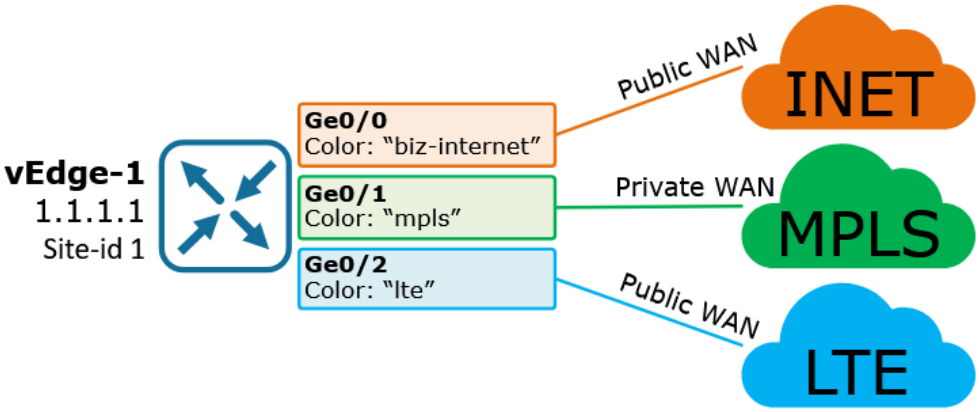
TLOC consists of several components, namely:

1. System IP

   Similar to the OSPF/BGP router-ID, it functions as the identifier for the vEdge device.

2. Transport Color

   The color here is used to differentiate between various transport links such as MPLS, Internet, LTE, Metro-E, etc. If the same transport link is used, colors like silver/gold can be utilized to distinguish them.



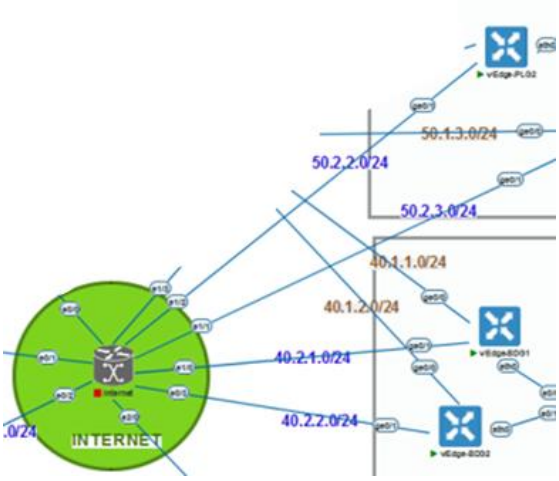
3. Encapsulation Type

   This is essential for advertising data plane connectivity or communication between vEdge devices, with two options available: IPsec or GRE.

After vBond receives the TLOC from vEdge, it forwards this information to vSmart (Controller), which is responsible for managing routing and policies. Once the TLOC is initiated and registered, vSmart handles the distribution of the TLOC to other SD-WAN devices to enable inter-site connectivity.

Step by step:

*note: The configuration process is the same for every vEdge. As an example, we will onboard **'vEdge-PLG02'**.



1. Setup Basic Config vEdge (system, VPN0, VPN512)

```
system
 host-name vEdge-PLG02
 system-ip 55.55.55.51
 site-id 50
 organization-name MRC
 clock timezone Asia/Jakarta
vbond 100.10.1.12

vpn 0
 interface ge0/0
  ip address 50.1.2.1/24
  tunnel-interface
   encapsulation ipsec
   color mpls
   allow-service all
  !
  no shutdown
```

```
 !
interface ge0/1
 ip address 50.2.2.1/24
 tunnel-interface
  encapsulation ipsec
  color public-internet
  allow-service all
 !
 no shutdown
!
 ip route 0.0.0.0/0 50.2.2.2
!
commit
```

2. Download & Install Root Certificate from Root_CA

```
// Download root-certificate
vEdge-PLG02# request download tftp://100.10.1.100/PKI.ca
------------------- If it is not possible, download via vshell -------------------
vEdge-PLG02# vshell
vEdge-PLG02:~$ tftp -g -r PKI.ca 100.10.1.100

// Install root-certificate
vEdge-PLG02# request root-cert-chain install home/admin/PKI.ca
```

3. Generate CSR from vEdge

```
// Create CSR from vEdge device with given name 'csr.txt'
vEdge-PLG02# request csr upload home/admin/csr.txt
Uploading CSR via VPN0
Enter organization-unit name       : MRC          < insert organization name
Re-enter organization-unit name    : MRC
```

```
Generating private/public pair and CSR for this vedge device
Generating CSR for this vedge device        .....[DONE]
Copying   ... /home/admin/cst.txt via VPN0
CSR upload successful

// Copy CSR that recently created
vEdge-PLG02# vshell
vEdge-PLG02:~$ ls
PKI.ca    archive_id_rsa.pub    csr.txt
vEdge-PLG02:~$ more csr.txt              < open csr.txt file, then manually copy CSR
```

4. **Request Signing to Root_CA & Paste granted certificate CSR into a new file**

// Request the Root_CA to approve (sign) the CSR of the vEdge.

1. Go to the Root_CA device, then type **'crypto pki server PKI request pkcs10 pem terminal'** and paste the CSR of vEdge-PLG02 that has been copied.
2. Type 'quit', and the granted certificate will be issued by Root_CA. Copy the granted certificate.

```
// Create new txt file, then paste granted certificate that already copied
vEdge-PLG02:~$ cat << "" > cert.txt                    << custom file
> **paste here**

// Install certificate from new file that contain granted certificate previously
vEdge-PLG02# request certificate install home/admin/cert.txt
Installing certificate via VPN 0
Successfully installed the certificate

** The certificate installed above generates a verified 'chassis & serial number' **
```

5. Add vEdge to Controller (Onboard vEdge based Chassis & Serial num)

// Copy chassis-number and serial-number from vEdge

vEdge-PLG02# show certificate serial

Chassis number: 55d1e2ba-caa0-4466-bc89-80971bcc383f serial number: 07

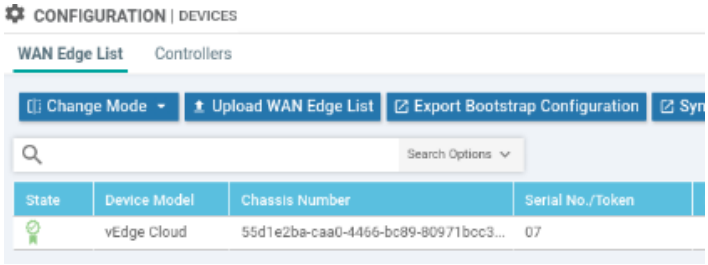
// Add vedge chassis and serial number to vManage & vBond

vManage# **request vedge add chassis-num 55d1e2ba-caa0-4466-bc89-80971bcc383f serial-num 07**

vBond# **request vedge add chassis-num 55d1e2ba-caa0-4466-bc89-80971bcc383f serial-num 07**

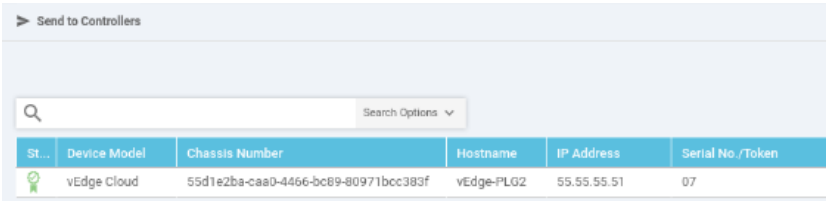
// Verification

1. Go to the vManage GUI, under Configuration > Device, perform a refresh
2. As a result, the vEdge will be successfully added to the controller

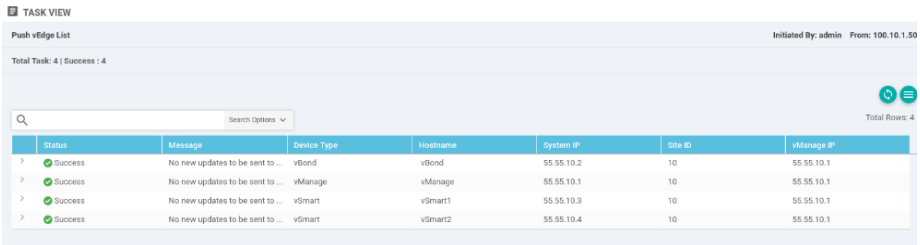


// Send vEdge certificate to Controller via vManage GUI

1. Go to Configuration > Certificate, on left side 'Send to Controllers'.



2. Then, certificate of the vEdge will pushed to controllers



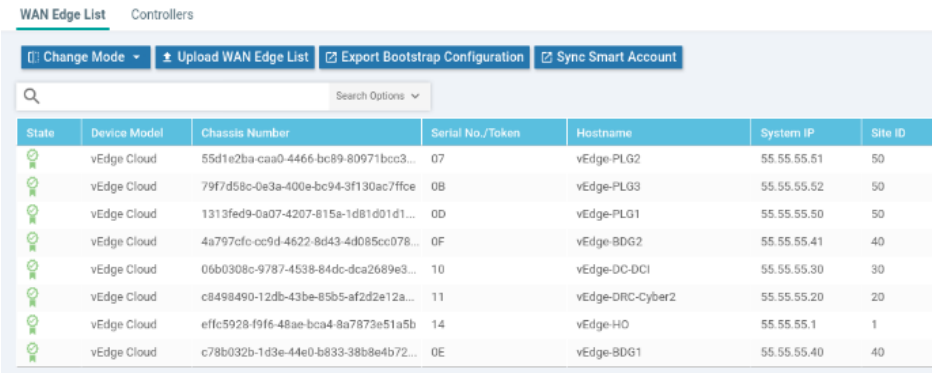
3. On vSmart, type ‘show control connections’. If the vEdge appears in the connection list, it means the vEdge onboarding process has been successful.

```
vSmart1# show control connections

      PEER    PEER PEER            SITE       DOMAIN PEER

INDEX TYPE    PROT SYSTEM IP       ID         ID     PRIVATE IP
UPTIME
---------------------------------------------------------------------------------------------
---------------
0     vedge   dtls 55.55.55.51     50         1      50.2.2.1
0:00:01:07
0     vsmart  dtls 55.55.10.4      10         1      100.10.1.14
0:02:42:03
0     vbond   dtls 0.0.0.0         0          0      100.10.1.12
0:02:42:22
0     vmanage dtls 55.55.10.1      10         0      100.10.1.11
0:02:42:20
1     vbond   dtls 0.0.0.0         0          0      100.10.1.12
0:02:42:24

vSmart1# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                         DOMAIN    OVERLAY   SITE
PEER            TYPE     ID        ID        ID        STATE    UPTIME           R/I/S
---------------------------------------------------------------------------------------------
55.55.10.4      vsmart   1         1         10        up       0:02:42:11       0/0/0
55.55.55.51     vedge    1         1         50        up       0:00:01:14       0/0/0
```

6. Verifikasi Onboarded vEdge

// vManage GUI > Configuration > Device

Perform the same process steps for all vEdges, and as a result, here is the outcome of all the onboarded vEdges.



// vSmart1# show omp peers

```
vSmart1# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                         DOMAIN    OVERLAY   SITE
PEER            TYPE     ID        ID        ID        STATE    UPTIME           R/I/S
---------------------------------------------------------------------------------------------
55.55.10.4      vsmart   1         1         10        up       0:18:08:08       0/0/0
55.55.55.1      vedge    1         1         1         up       0:00:13:23       0/0/0
55.55.55.20     vedge    1         1         20        up       0:00:14:12       0/0/0
55.55.55.30     vedge    1         1         30        up       0:00:14:16       0/0/0
55.55.55.40     vedge    1         1         40        up       0:00:00:48       0/0/0
55.55.55.41     vedge    1         1         40        up       0:00:14:22       0/0/0
55.55.55.50     vedge    1         1         50        up       0:13:38:32       0/0/0
55.55.55.51     vedge    1         1         50        up       0:15:27:12       0/0/0
55.55.55.52     vedge    1         1         50        up       0:14:16:37       0/0/0
```

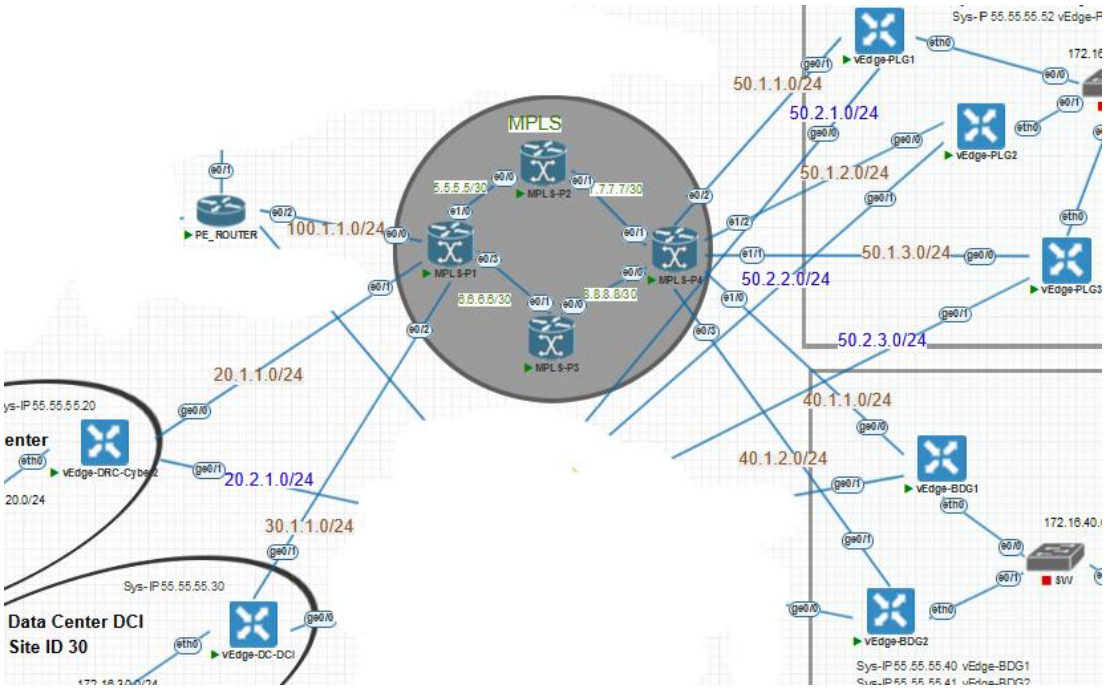
BRING-UP MPLS TRANSPORT

In the previous vEdge onboarding process to the controller, **we used the public internet** for the transport link. In this scenario, we will also enable the MPLS transport link as redundancy and traffic segmentation between the vEdge and the controller.

When using multiple transport links for redundancy and high availability, there is a protocol known as **Bidirectional Forwarding Detection (BFD)**. This is used to monitor the real-time condition of the underlying network, and if there is a failure in the transport link, it will detect it very quickly. BFD is enabled by default on vEdge, so if there are multiple transport links, a BFD session will be automatically established.

To enable MPLS transport to the SD-WAN fabric, **we just need to establish reachability between the vEdge and the controller**. Once the vEdge is connected to the controller, the MPLS transport link will be operational within the SD-WAN fabric.

Step by step:



1. **Setup OSPF point-to-point on MPLS-P1 MPLS-P2 (link ke vEdge)**

PE_Router

```
interface Ethernet0/2
 ip ospf network point-to-point
```

MPLS-P1

```
interface range Ethernet0/0-2
 ip ospf network point-to-point
```

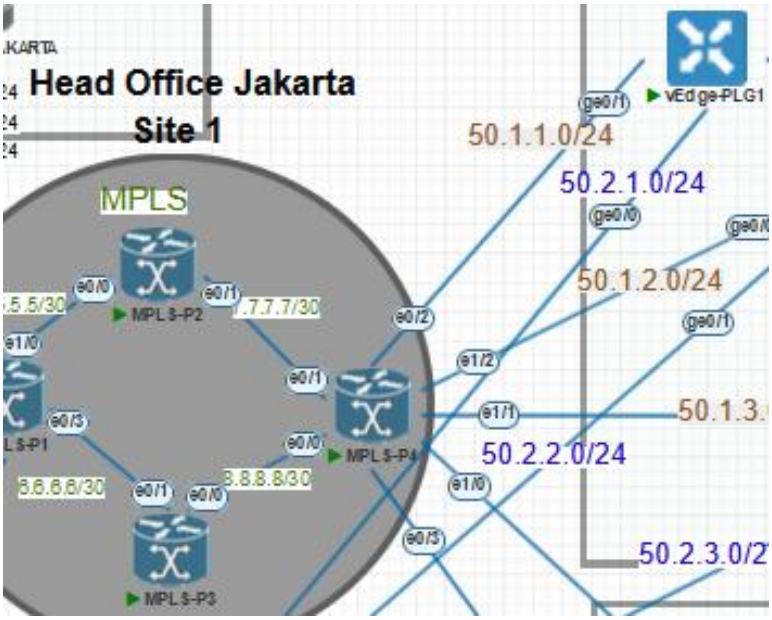
MPLS-P4

```
interface range Ethernet0/2-3, Ethernet1/0-2
 ip ospf network point-to-point
```

2. **Configure OSPF on all vEdge (for reachability to controllers through MPLS)**

****notes: konfigurasinya sama pada semua vEdge**

// sebagai contoh disini kita akan mengkonfigurasi vEdge-PLG1



// Peering OSPF pada vEdge-PLG1

```
vpn 0
 router ospf
```

```
router-id 55.55.55.50
area 0
 interface ge0/1
  network point-to-point
 exit
exit
!
```

3. Verification OSPF reachability to controller

// show ospf neighbor

```
vEdge-PLG1# show ospf neighbor
DBsmL -> Database Summary List
RqstL -> Link State Request List
RXmtl -> Link State Retransmission List
        SOURCE
VPN     IP ADDRESS        INTERFACE         ROUTER ID         STATE
-------------------------------------------------------------------
0       50.1.1.2          ge0/1             2.2.2.4           full
```

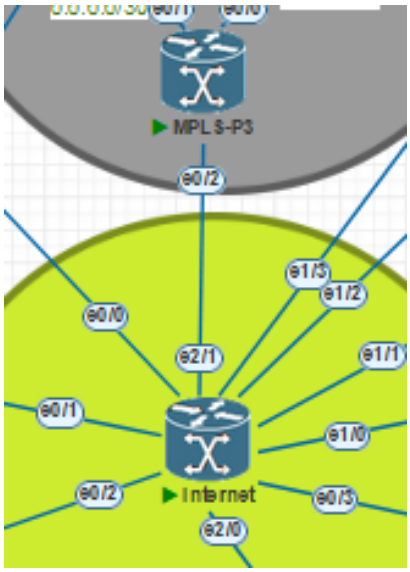
// show ip route

```
                                                PROTOCOL  NEXTHOP     NEXTHOP
VPN     PREFIX              PROTOCOL            SUB TYPE  IF NAME     ADDR
-------------------------------------------------------------------------------
0       0.0.0.0/0           static              -         ge0/0       50.2.1.2
0       1.1.1.0/24          ospf                IA        ge0/1       50.1.1.2
0       2.2.2.1/32          ospf                IA        ge0/1       50.1.1.2
0       2.2.2.2/32          ospf                IA        ge0/1       50.1.1.2
0       2.2.2.3/32          ospf                IA        ge0/1       50.1.1.2
0       2.2.2.4/32          ospf                IA        ge0/1       50.1.1.2
0       5.5.5.0/30          ospf                IA        ge0/1       50.1.1.2
0       6.6.6.0/30          ospf                IA        ge0/1       50.1.1.2
0       8.8.8.0/30          ospf                IA        ge0/1       50.1.1.2
0       30.1.1.0/24         ospf                IA        ge0/1       50.1.1.2
0       40.1.1.0/24         ospf                IA        ge0/1       50.1.1.2
0       40.1.2.0/24         ospf                IA        ge0/1       50.1.1.2
0       50.1.1.0/24         ospf                IA        ge0/1       -
0       50.1.1.0/24         connected           -         ge0/1       -
0       50.1.2.0/24         ospf                IA        ge0/1       50.1.1.2
0       50.2.1.0/24         connected           -         ge0/0       -
0       55.55.55.50/32      connected           -         system      -
0       100.1.1.0/24        ospf                IA        ge0/1       50.1.1.2
0       100.2.1.0/24        ospf                IA        ge0/1       50.1.1.2
0       100.10.1.0/24       ospf                IA        ge0/1       50.1.1.2
```

// show control connections (make sure MPLS STATE UP)

```
vEdge-PLG1# show control connections
                                                
```

4. Connect MPLS & Internet to Bring UP Full BFD Session/Reachability



We will use OSPF to advertise routes connected to the internet, so that both transport links have reachability and can activate the BFD session.

**** notes: For example, vEdge-PLG1 communicates with vEdge-BDG1 using the same transport link, MPLS (MPLS to MPLS). However, if one of the MPLS links fails, BFD will act quickly and switch to the public internet transport link (MPLS to Public Internet).**

// INTERNET

```
interface Ethernet2/1
 ip address 3.3.3.1 255.255.255.252
 ip ospf network point-to-point
 shutdown
 duplex auto
!
router ospf 1
 router-id 3.3.3.3
 network 0.0.0.0 255.255.255.255 area 0
!
```

// MPLS-P3

```
interface Ethernet0/2
```

ip address 3.3.3.2 255.255.255.252

ip ospf network point-to-point

duplex auto

end

!

** OSPF sudah aktif di MPLS-P3

// Semua BFD Session antara MPLS dan Public Internet menjadi aktif

```
vEdge-PLG1# show bfd sessions
                                       SOURCE TLOC      REMOTE TLOC
SYSTEM IP        SITE ID  STATE       COLOR            COLOR            SOURCE IP
NS
-------------------------------------------------------------------------------
55.55.55.1       1        up          mpls             metro-ethernet   50.1.1.1

55.55.55.1       1        up          public-internet  metro-ethernet   50.2.1.1

55.55.55.20      20       up          mpls             public-internet  50.1.1.1

55.55.55.20      20       up          public-internet  public-internet  50.2.1.1

55.55.55.30      30       up          mpls             public-internet  50.1.1.1

55.55.55.30      30       up          public-internet  public-internet  50.2.1.1

55.55.55.40      40       up          mpls             public-internet  50.1.1.1

55.55.55.40      40       up          public-internet  public-internet  50.2.1.1

55.55.55.41      40       up          mpls             public-internet  50.1.1.1

55.55.55.41      40       up          public-internet  public-internet  50.2.1.1
```

VMANAGE TEMPLATE OVERVIEW

Device Template & Feature Template

Previously, we used CLI for all device configurations. CLI is a good way to quickly configure something, but it is not scalable. CLI is suitable for configuring a few devices, but if we need to handle dozens of devices, it will take too much time and could lead to errors. An alternative way to address this weakness is by using templates.

One of the powerful features in SD-WAN is the ability to provide templates. With this feature, we simply create a set of configuration templates and push them to the devices. We create the template first and then apply it to one or as many devices as needed. This feature is scalable, saving time and reducing the likelihood of configuration errors.

There are 2 types of templates, namely:

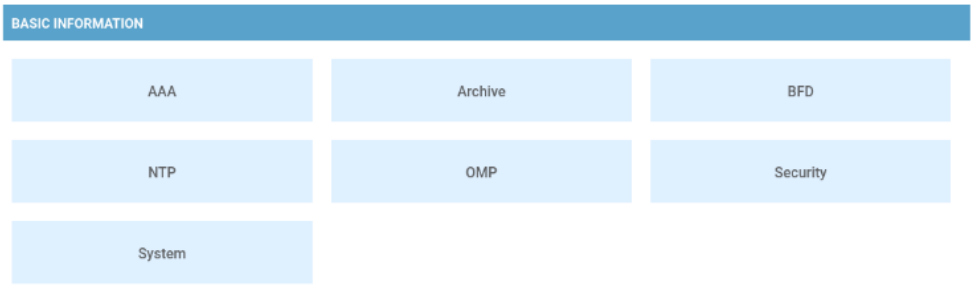
Device template

This can be considered a collection of several feature templates, where a specific device model can be associated with a device template (such as Cisco ISR, CSR, Catalyst 8000 series, vEdge 100, vEdge 200, etc.). This is the template that will be attached to the device.

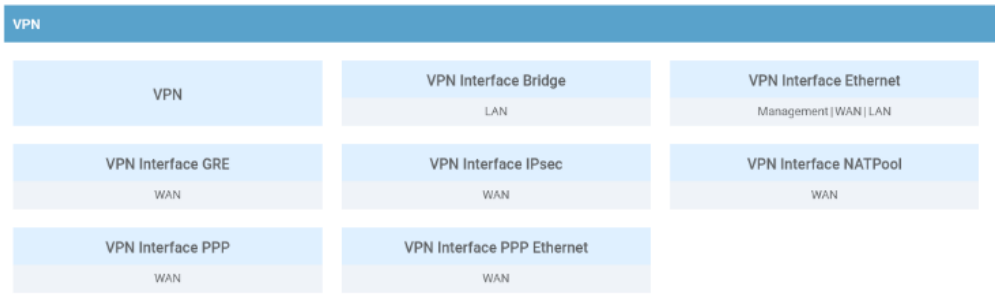
Feature template

We create a feature template for each 'feature' that we want to configure. One feature template can be used across multiple device templates. Feature templates have three categories, namely:

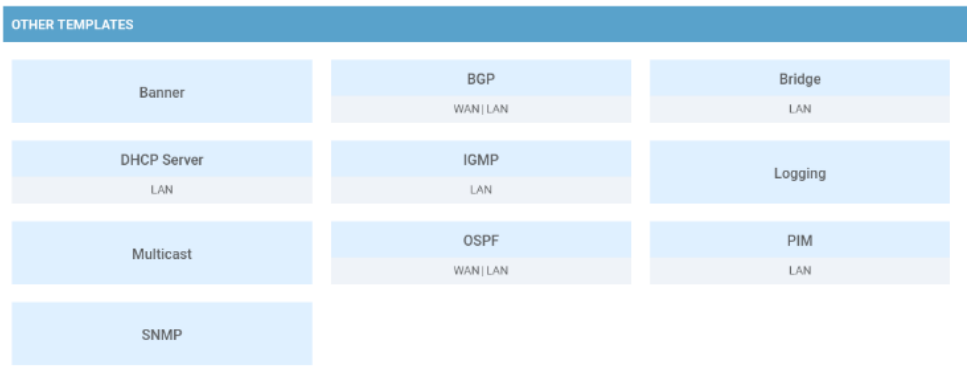
a. Basic Configuration



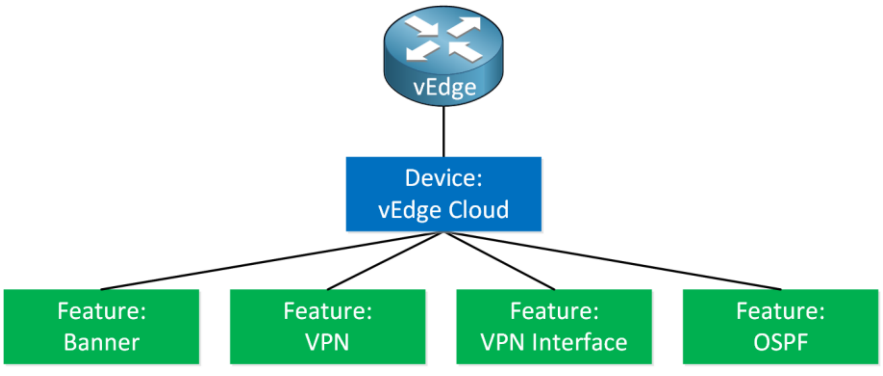
b. VPN



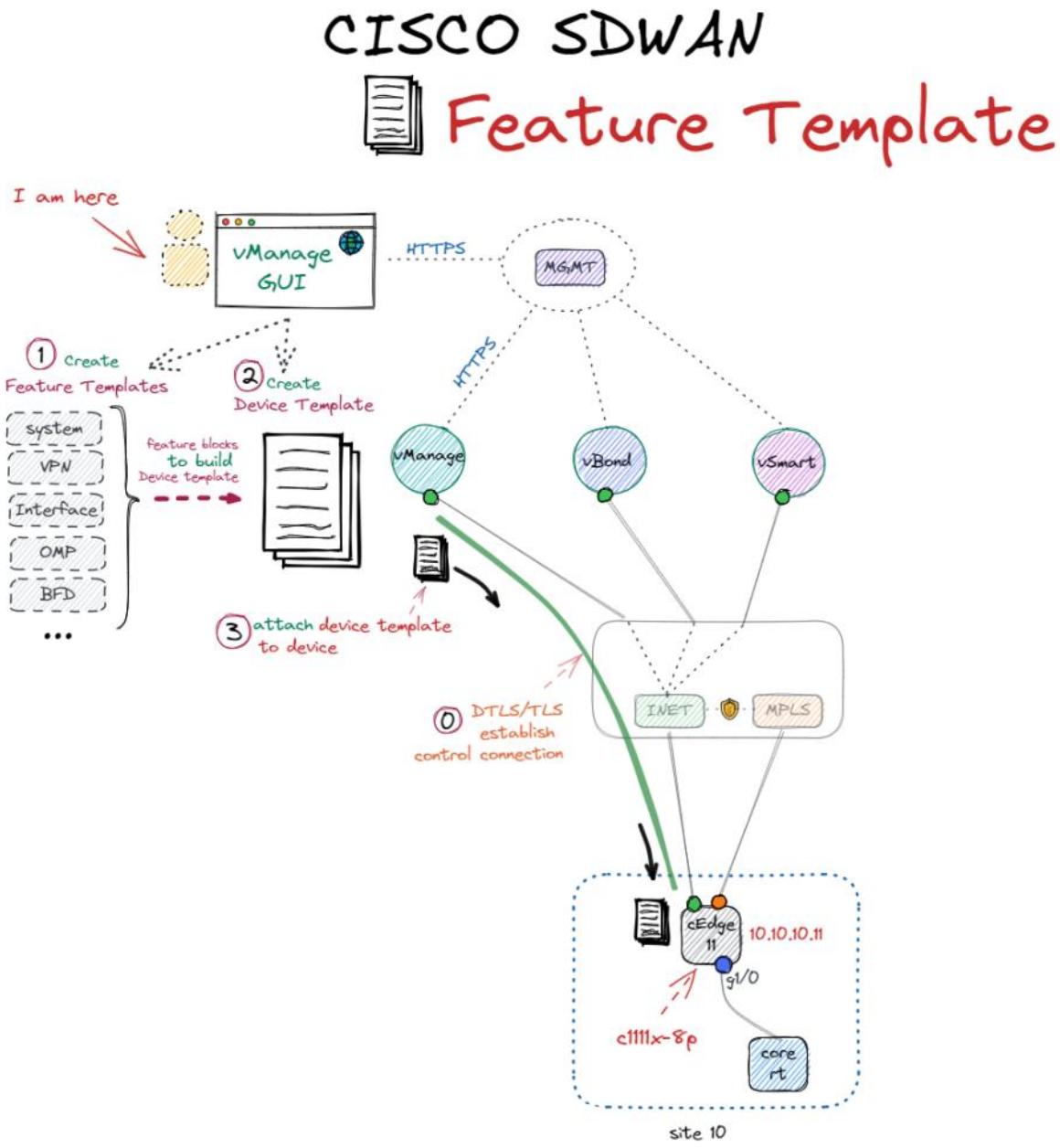
c. Other Templates



There is a 'parent-child' relationship between the Device template and the Feature template. First, we create the Feature template and place it into the Device template. Then, we attach the Device template to the device, such as the vEdge Cloud router.



How the templates are created and deployed



Source: https://blogs.itbase.tv/part-10-cisco-sd-wan-configuration-templates

The user configures the template through vManage, creating a collection of feature templates that will be assigned to the device template. Once the device template and the collection of feature templates are ready, the device template is pushed/attached to the vEdge via the DTLS tunnel. As a result, the vEdge is now in vManage mode. It is important to note that **once a vEdge is set to vManage mode** (via template), **it can no longer be configured using CLI mode.**

Device Template Method

In template configuration, a device template can be attached with a set of predefined feature templates. **A device template can be attached to multiple vEdges simultaneously, but if one vEdge wants to add a new parameter, other vEdges attached to that device template will also be affected**.

Templates are created to overcome the limitations of CLI mode, offering flexibility and ease in applying configurations. There are several methods that can be used to flexibly create templates for vEdges according to specific needs, such as:

1. Initial templates

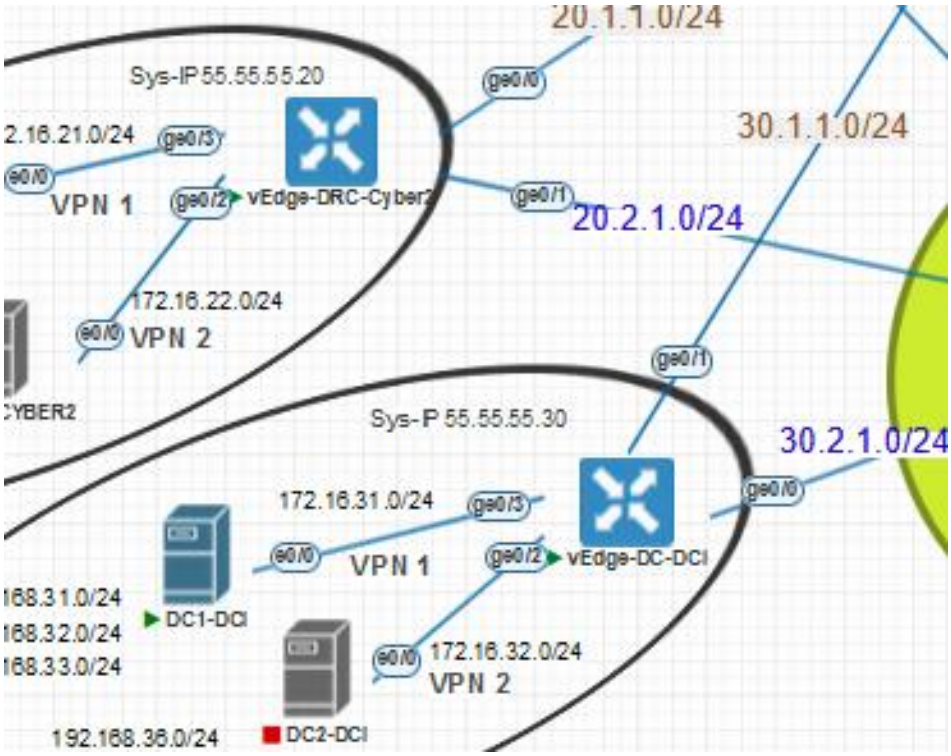
   These are the initial templates that can be applied to all vEdges when joining the SD-WAN fabric. They consist of common configurations shared by all vEdges in their interconnection to the SD-WAN fabric, such as VPN0, System, OSPF/BGP for MPLS transport link, default route to the public internet, etc.
2. Spesific device template

   This is for specific devices that require special configurations, such as having multiple service VPNs, specific policies, or custom features.
3. One transport link template (MPLS only / Internet only)

   This can be used for vEdges that have only a single transport link, either MPLS or Internet.
4. Custom templates

   Custom templates allow users to define specific configurations tailored to particular needs or use cases within the SD-WAN network

Step by step:



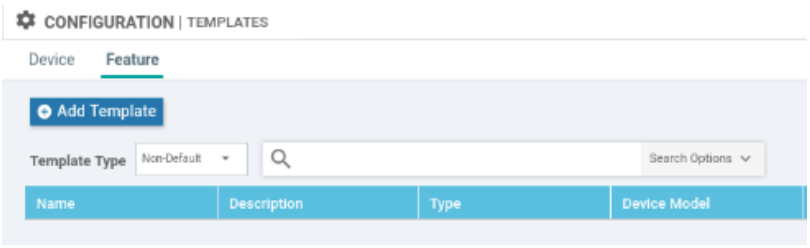
We will attempt to configure vEdge-DC-DCI and vEdge-DRC-Cyber2 through vManage Device Template. They have VPN 0 along with OSPF routing for MPLS and a default route for the internet, VPN 1, and VPN 2, for which we will create feature templates. However, the focus in this section will be on configuring VPN 0 only, while the Service VPN will be covered in another section. Additionally, we will also configure System and Banner, and then in the same device template, both devices will be attached to the template.

1. **Create and setup Features template**

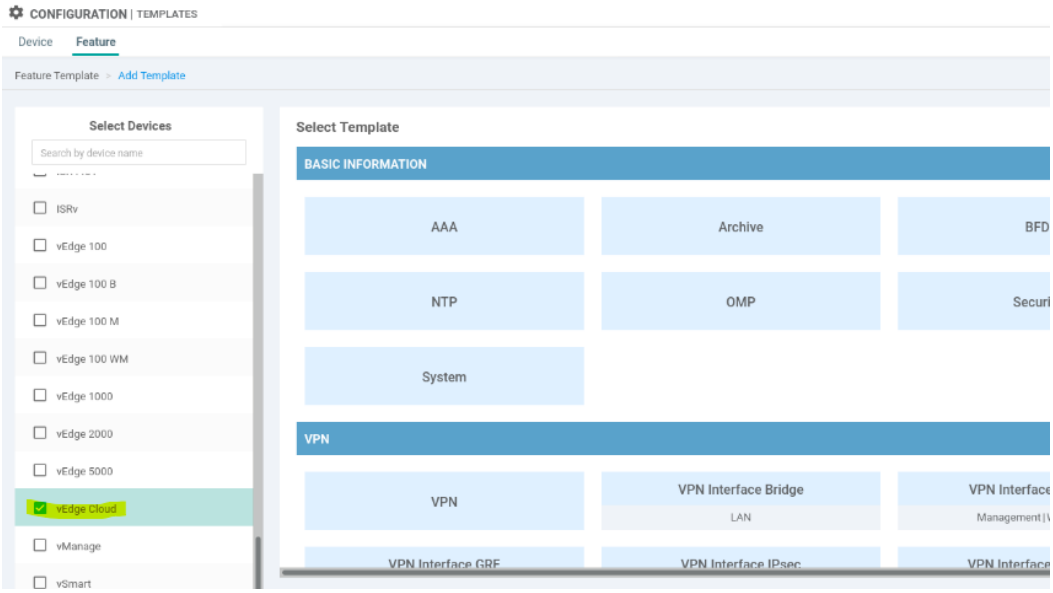
In the feature template we will create, our focus will be on VPN 0 for both devices. There are 4 sections for the 'vEdge Cloud' device we will use: 'Basic Configuration', 'VPN', and 'Other Template'. In the configuration scenario, we will create the following feature templates:

- **Basic Configuration**: System
- **VPN**: VPN (VPN 0 & VPN 512), VPN Interface (Ge0/0, Ge0/1, Eth0)
- **Other Template**: Banner, OSPF (MPLS interconnection)

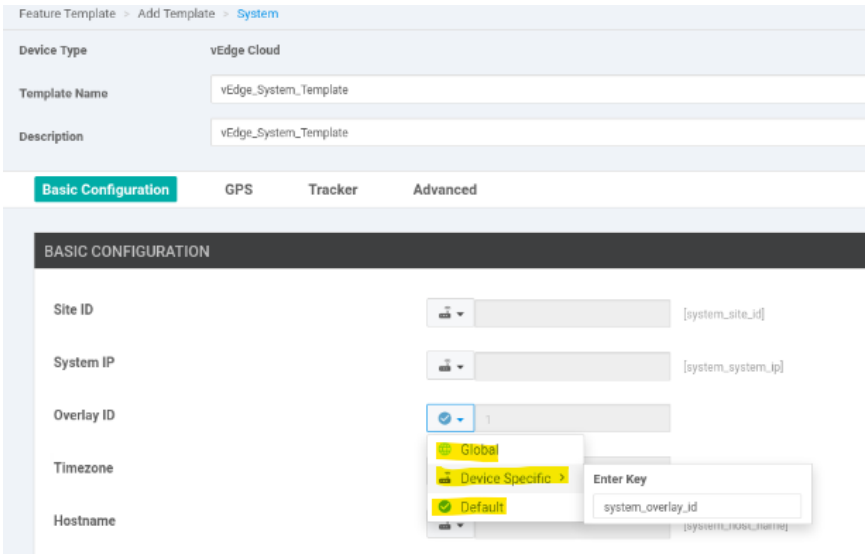
1. Go to vManage GUI, Configuration > Templates > Features, then select 'Add Template'



2. On 'Select Device' section, choose the desired device model, here we are using 'vEdge Cloud', then on the right you will see the templates that can be used.



3. We will start with the 'System' template, click on the template and give it a name and description.



***quick notes:**

There are 3 options that can be used:

- Global (Globe icon)

  This is applied to all devices using this feature template. For example, VPN ID or Console Baud Rate.

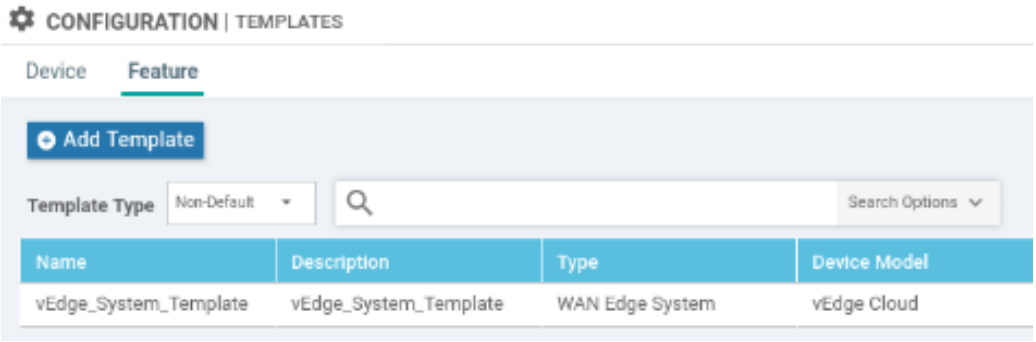
- Default (Checklist icon)

  This has several options predefined by vManage, and can be selected, such as timezone or Overlay ID.

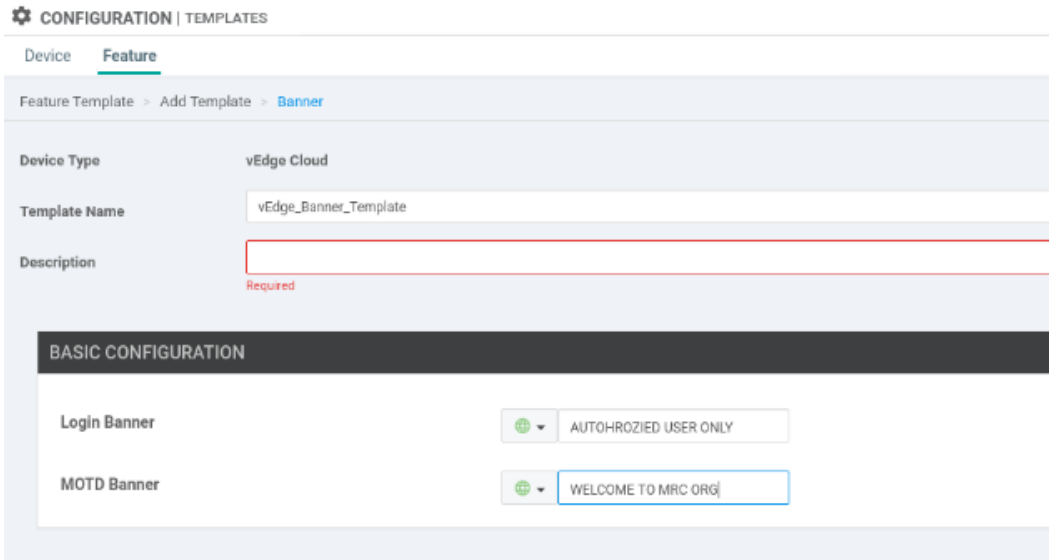
- Device specific (Radio icon)

  We can apply this to several devices that have their own values, such as Site ID and System IP. This option is set in the form of variables, which will later be filled by the specific device (e.g., [system_site_id])

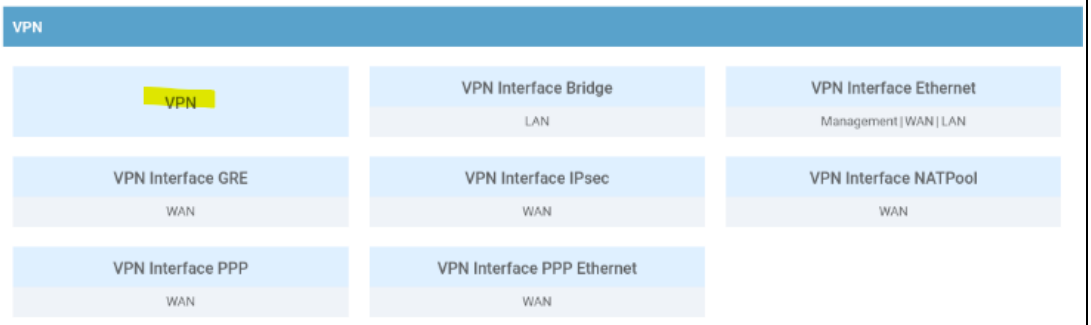
4. In the 'Basic Configuration' section, fill in according to the intended template usage, then 'Save'. This system template is now ready to be used for the Device template



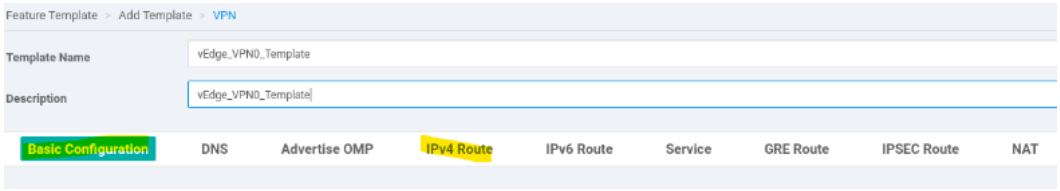
5. Other template > Banner Templates, save



6. VPN > VPN



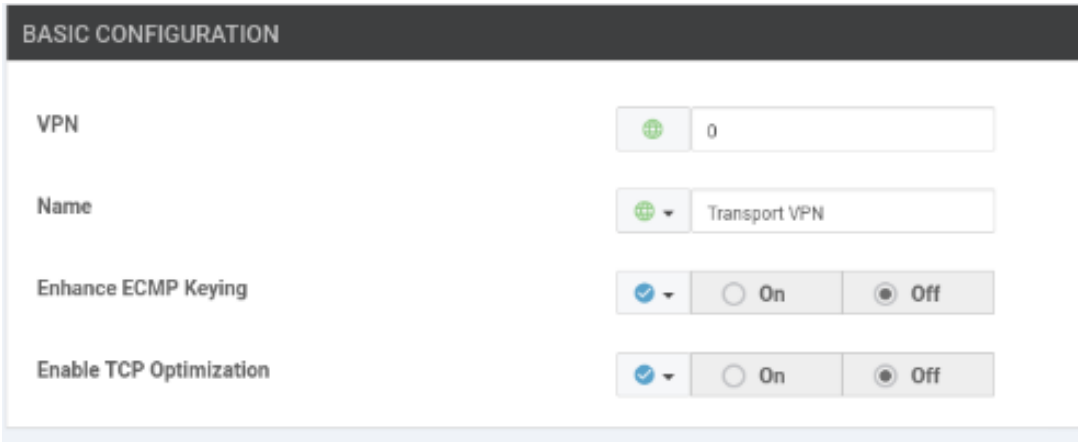
7. On 'VPN' template, there is several section as follows



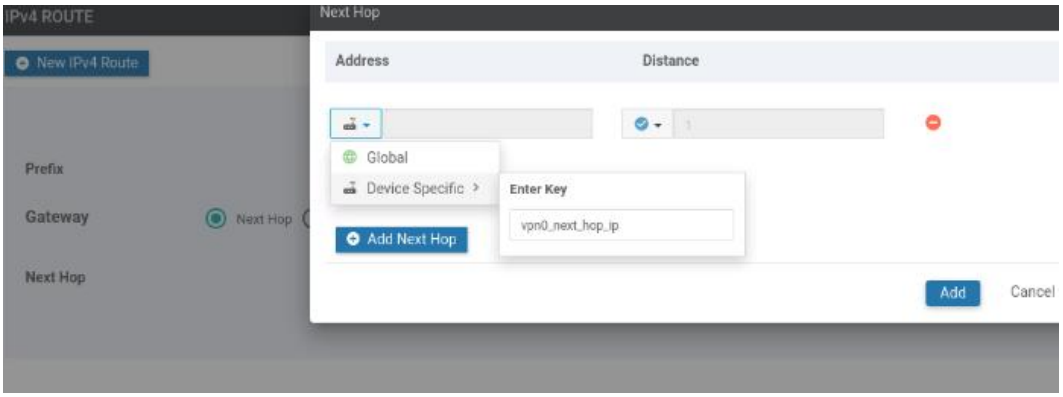
8. **[VPN 0 Templates]**

   Here we are only configuring 'Basic Configuration' and 'IPv4 Route' as the transport link, but for VPN1 and VPN2, the 'Advertise OMP' section needs to be configured based on the routing protocol to be advertised.

9. In 'Basic Configuration', select the **Global** option for VPN and Name, then set it to 0 (VPN0) and name the VPN as 'Transport VPN'

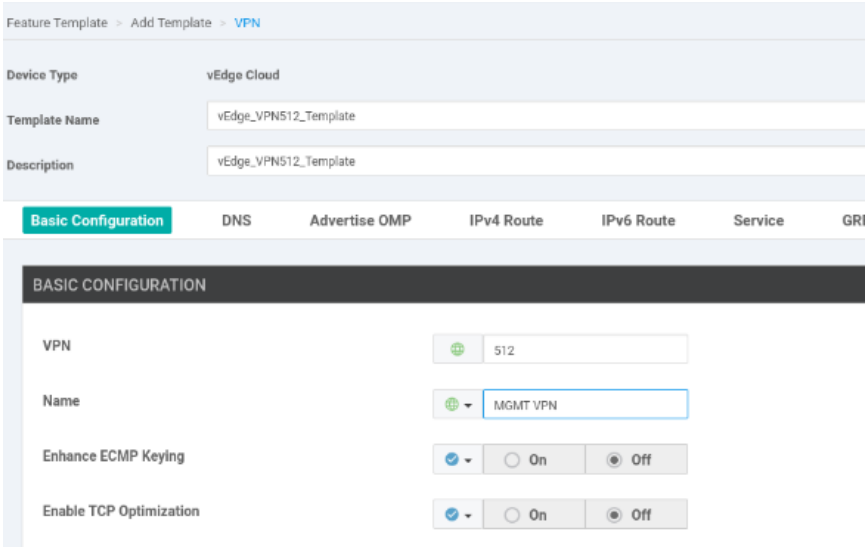


10. Scroll down to the 'IPv4 routes' section, click 'New IPv4 Route'. We will use the **Global** option for Prefix since we will set the default route to the Internet (0.0.0.0/0). For the Gateway, choose **Next hop** Device specific option, then create the variable like the following, then 'Add'. Finally, 'Save' the VPN template.

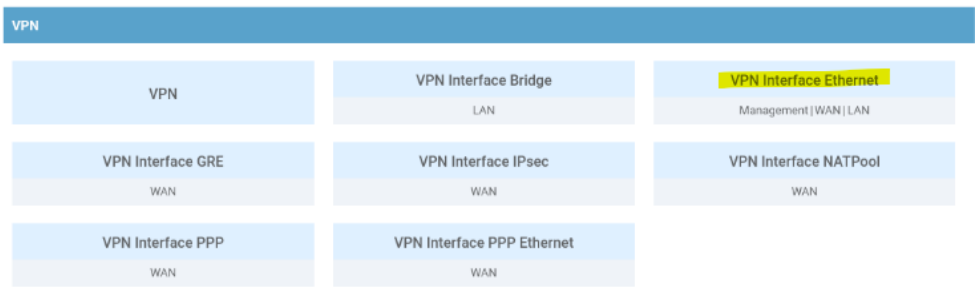


11. **[VPN 512 Template]**

    For VPN 512, we will only configure 'Basic Configuration', there is no IPv4 route for this VPN

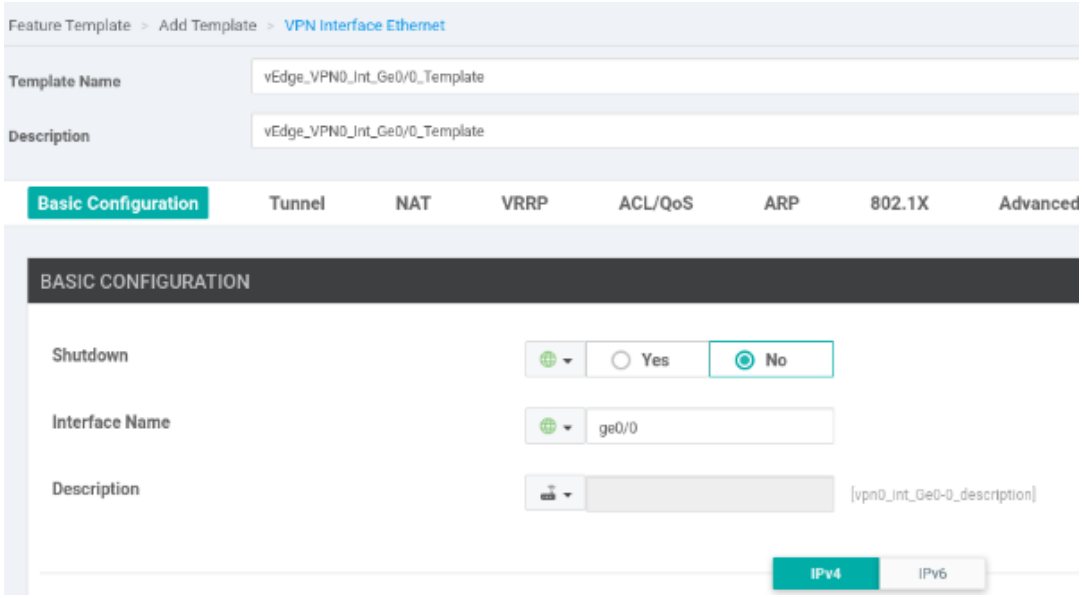


12. VPN > VPN Interface

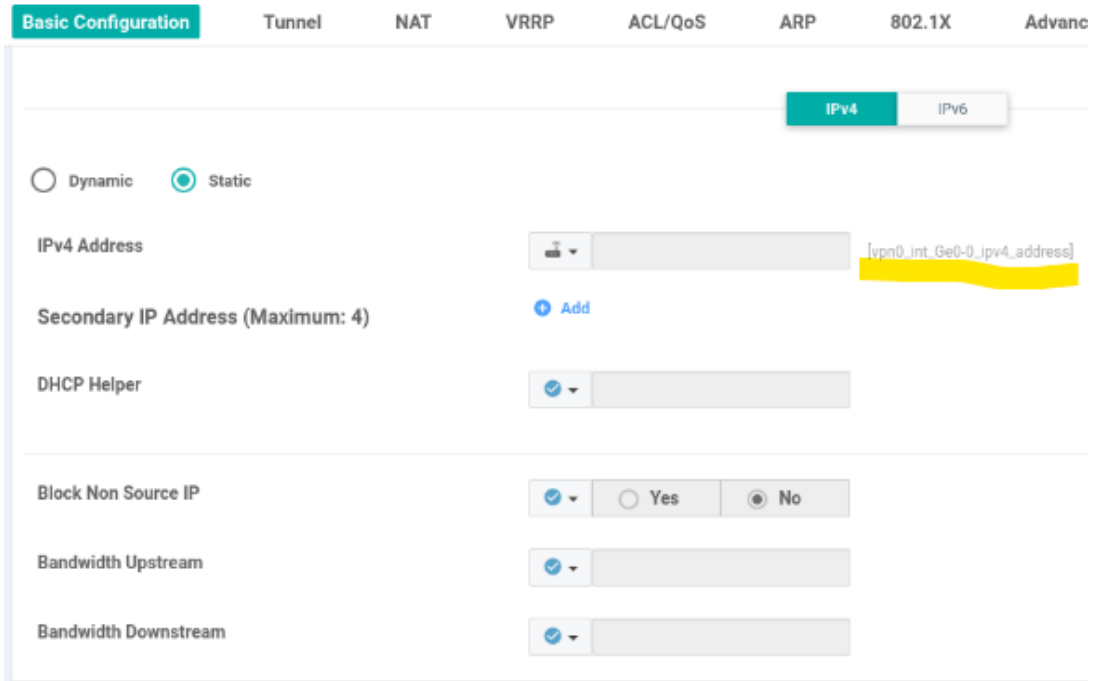


13. **[VPN 0, Interface Ge0/0]**

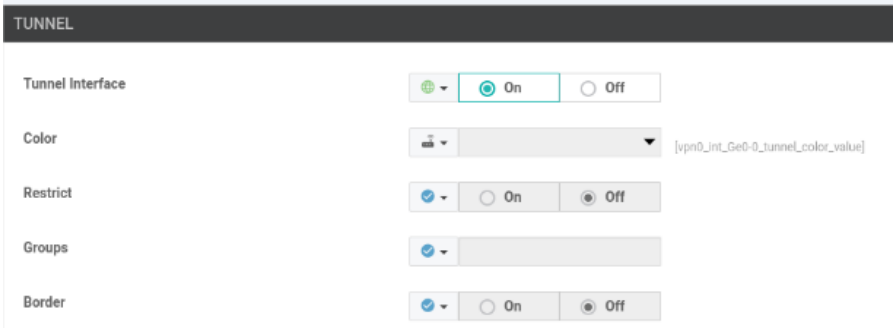
    Give the template a name, set Shutdown to 'No', then specify the interface name and description



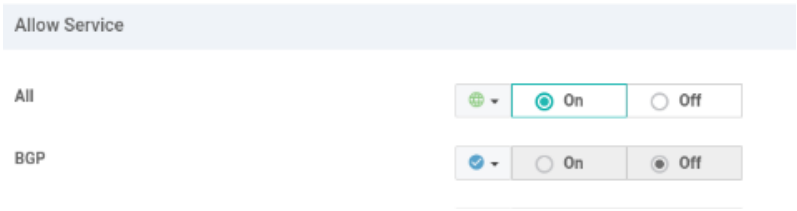
14. In the 'Basic Configuration' section, select 'IPv4', then Static, and change the variable for Device option in 'IP address'



15. Since this is for the transport link, enable 'Tunnel interface', and for 'Color', we use Device specific with the following variable

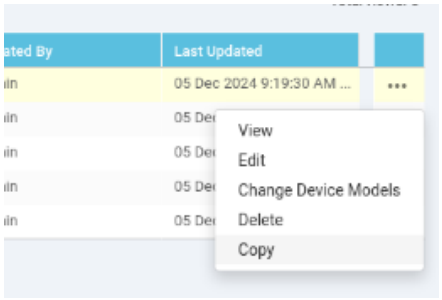


16. Allow service all, then save



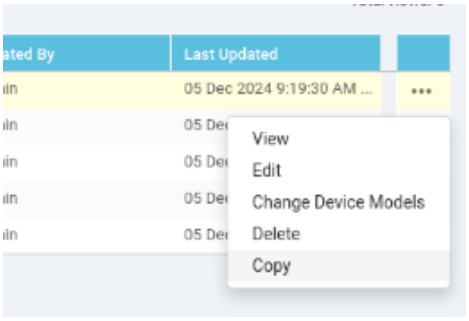
17. **[VPN 0, Interface Ge0/1]**

Do the same as for interface Ge0/0, or copy the Ge0/0 Template, then change according to the Ge0/1 parameters.

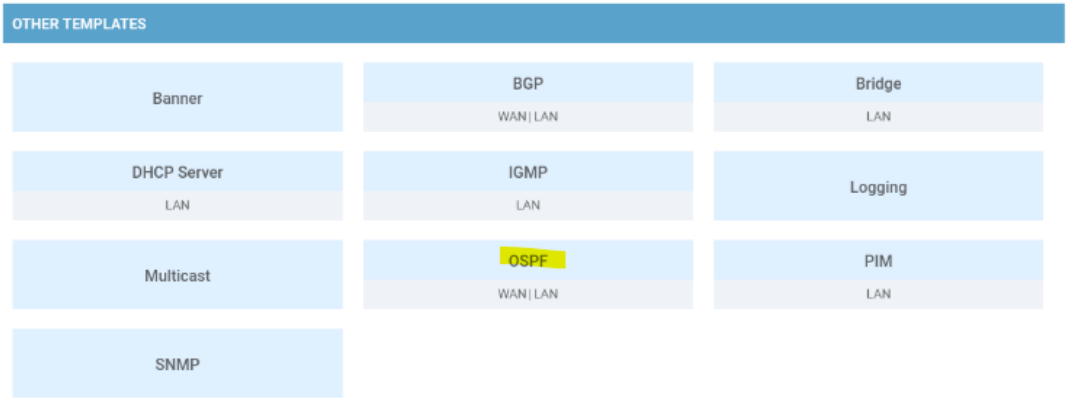


18. **[VPN 512, Interface eth0]**

Do the same as for interfaces Ge0/0 and Ge0/1, or copy the previous template, then change according to the eth0 parameters (default IP address). **For VPN 512, the tunnel interface does not need to be enabled.**

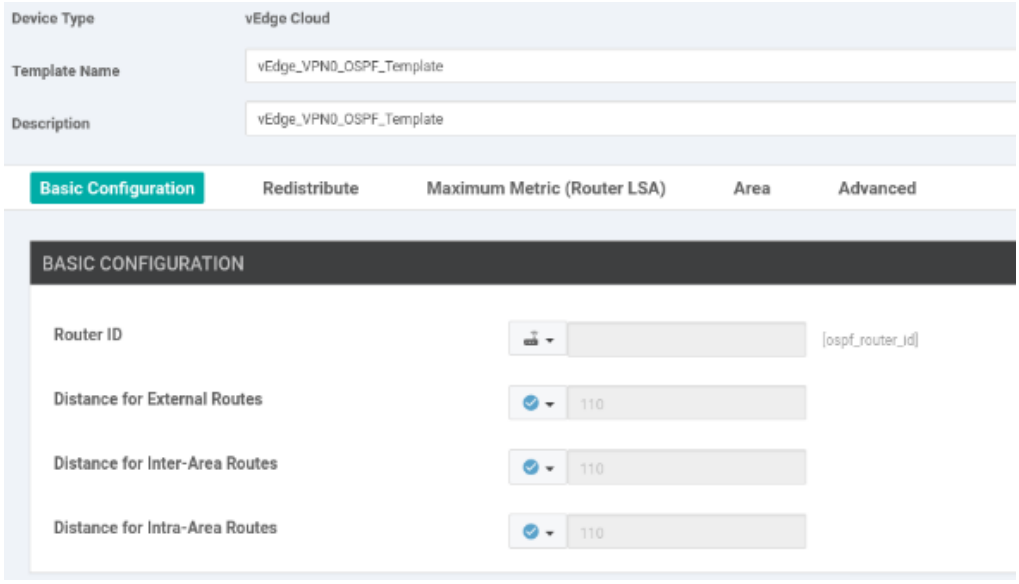


19. Other Template > OSPF (for MPLS link)

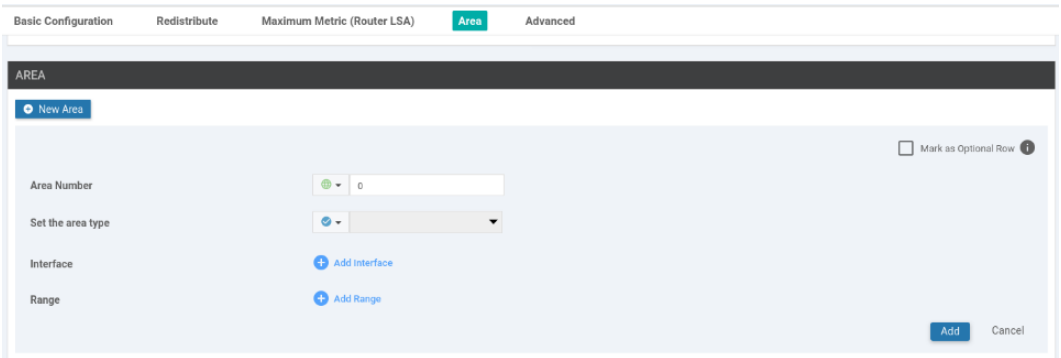


20. **[OSPF Template]**

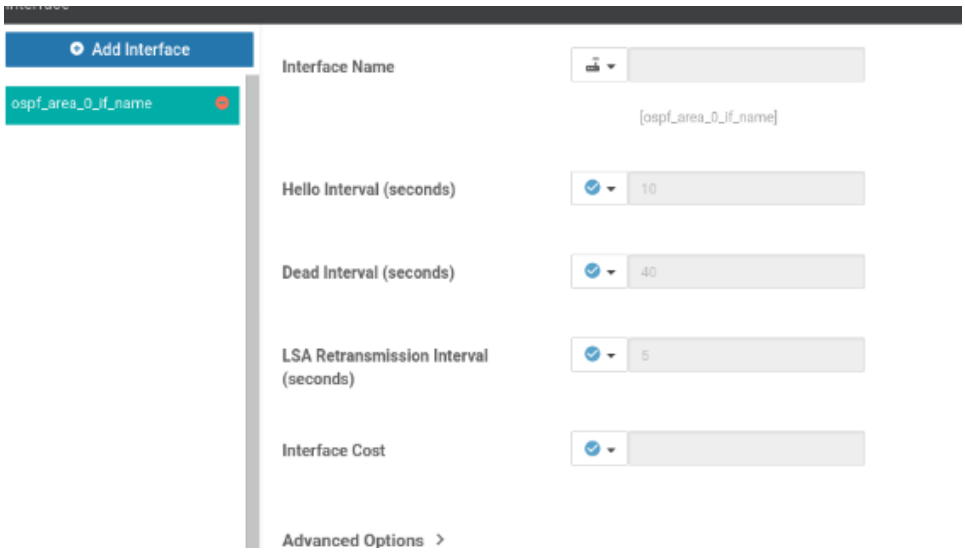
Set the template name, then for 'Router-id', select the Device specific option



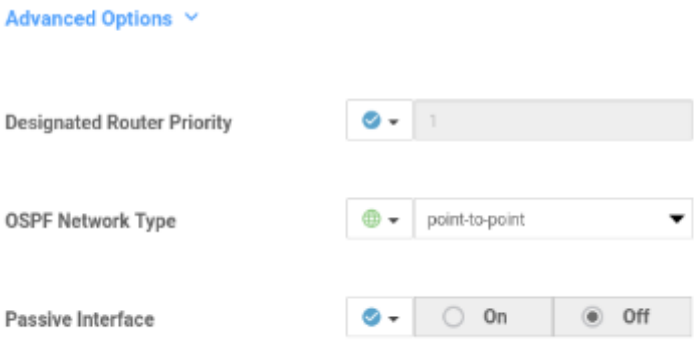
21. In the 'Area' section, define the area number, then 'Add interface'.



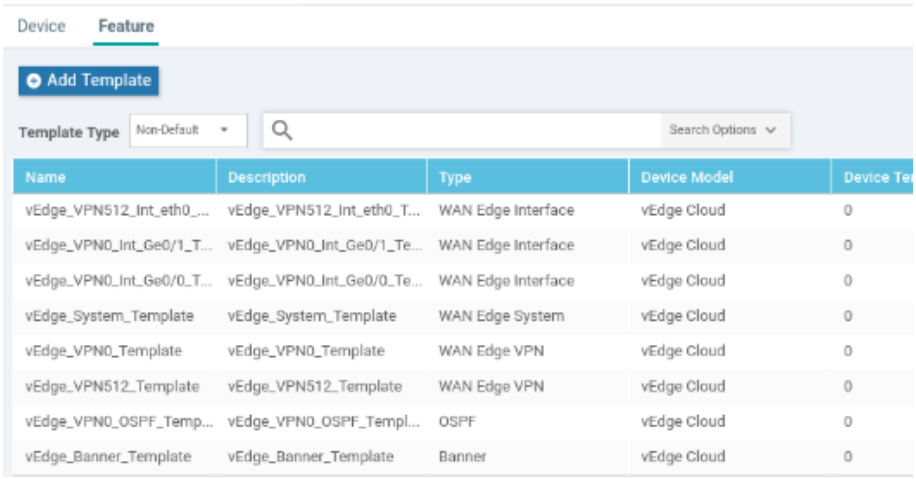
22. For ‘Interface Name’, select Device specific with the variable for the interface name.



23. Click ‘Advanced Options’, then select Point-to-Point for OSPF network type, then Save.

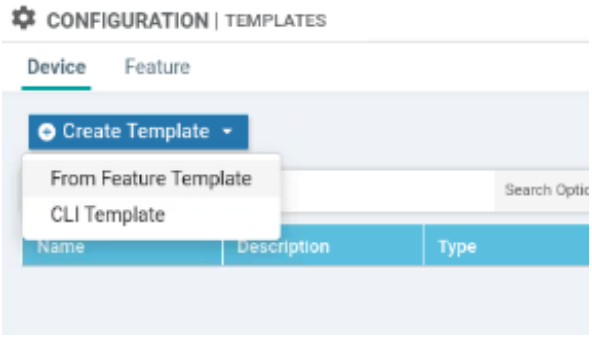


24. This way, the Feature template is ready to be used and attached to the Device Template

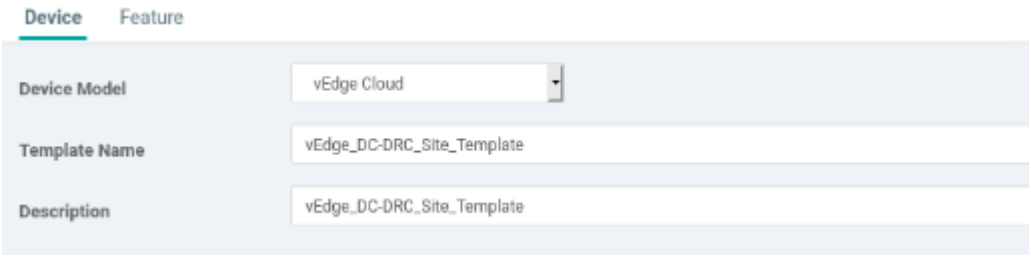


2. Create and setup Device template

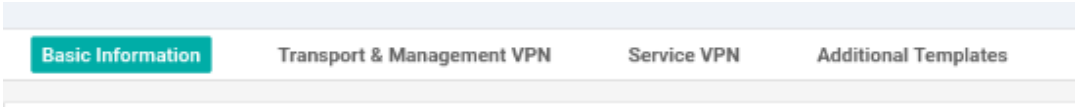
1. Go to Configuration > Templates > Device template, then click 'Create Template' and select 'From Feature Template'.



2. Specify the Device model, Template Name, and description of the Device template to be created.

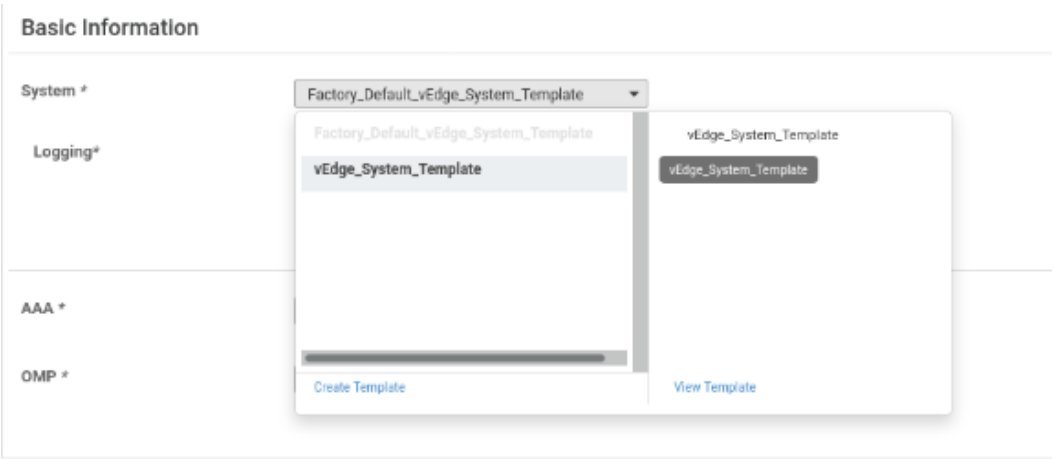


3. There are 4 sections in the Device template, which are:



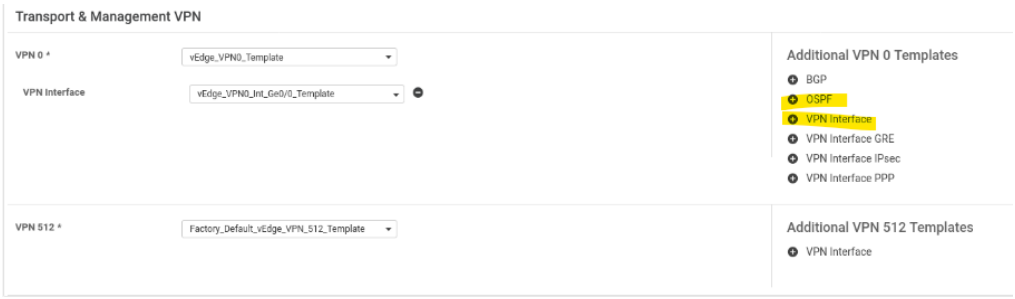
4. **[Basic Information]**

   Specify the Feature templates that have been created according to the template type to be associated with the Device Template.



5. **[Transport & Management VPN]**

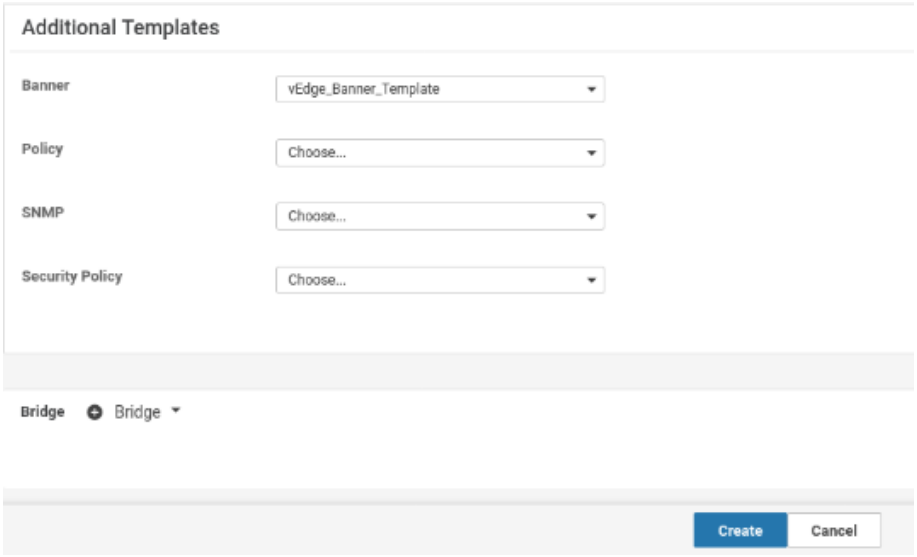
   Add the Additional VPN 0 Template for OSPF and VPN interface.



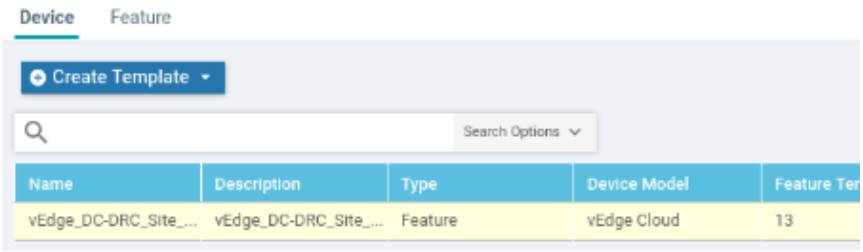
6. Associate the feature templates that have been created.

7. **[Additional Template]**

   Add the Banner from the feature template that was created, then click ‘Create’.

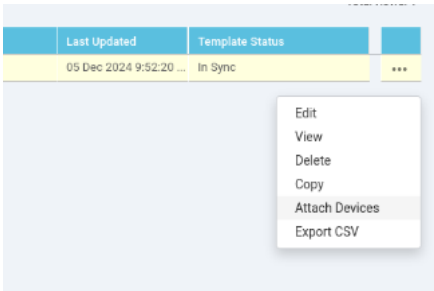


8. With that, the Device template is successfully created and ready to be attached to the device

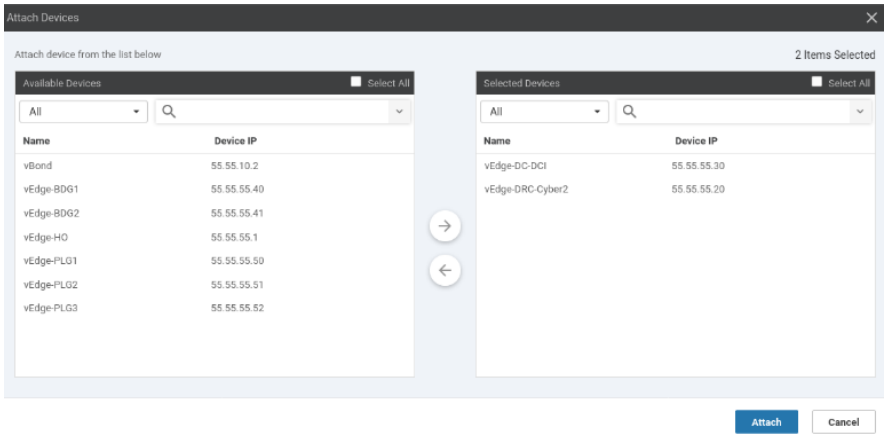


3. Attach Device template to Device

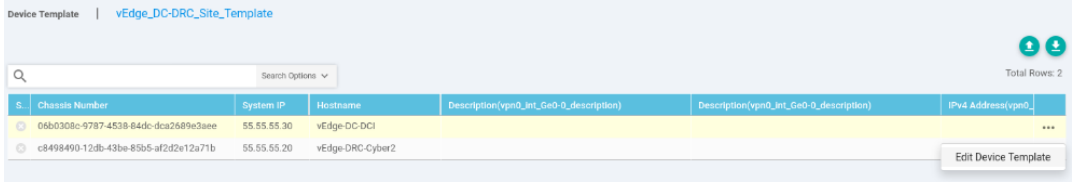
1. n Configuration > Template > Device Template, select the Device template that has been created, then on the far right, select ‘Attach Devices’.



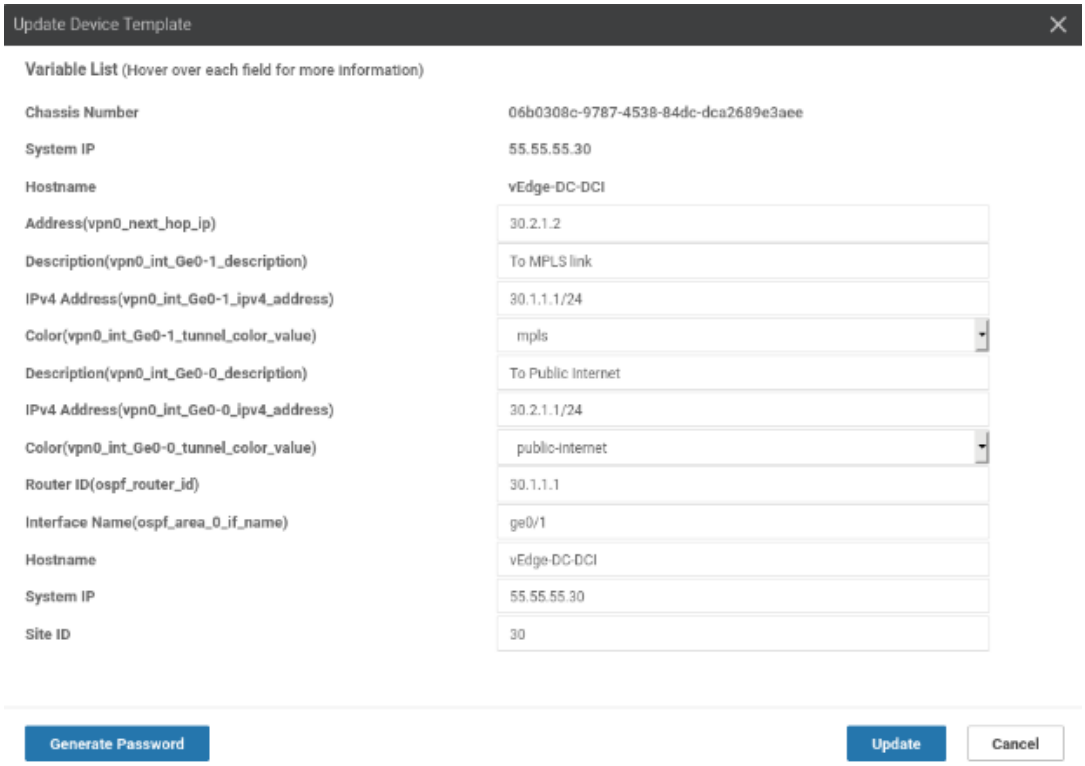
2. Move DRC-Cyber and DC-DCI to the right to apply the device template that has been created, then click ‘Attach’.



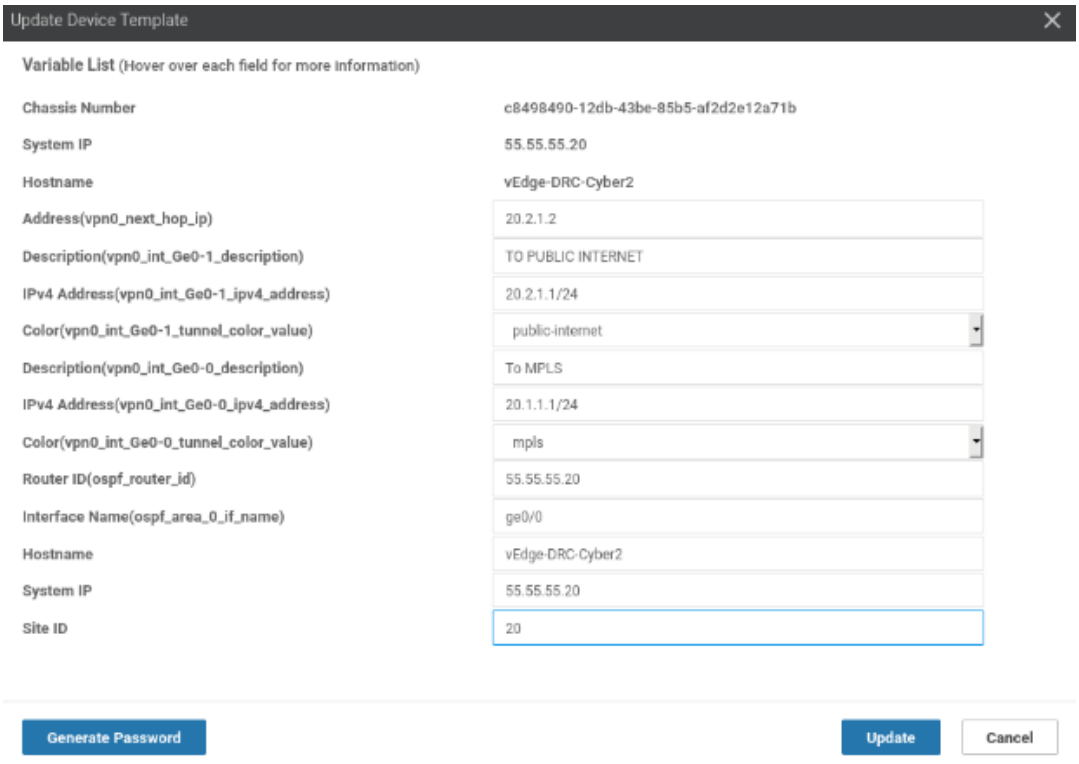
3. ‘Edit Device Template’ for each device, according to the values for each device.



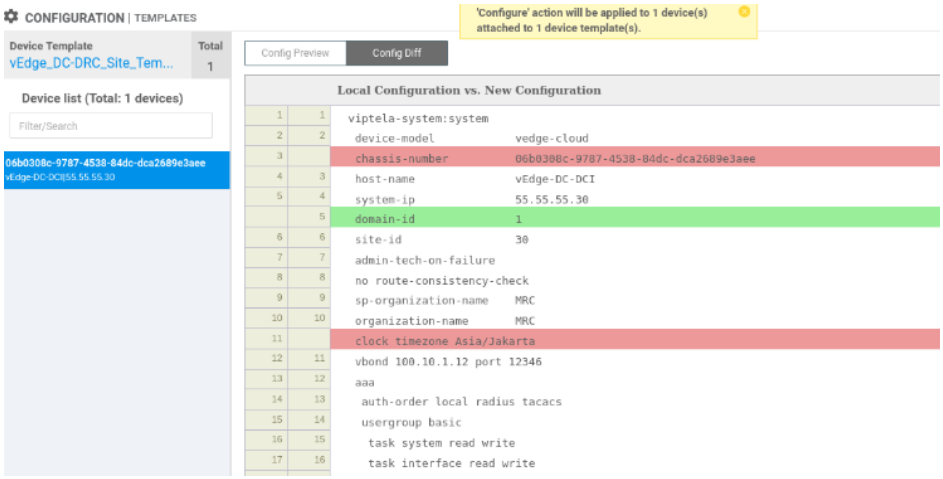
4. **[vEdge-DC-DCI]**



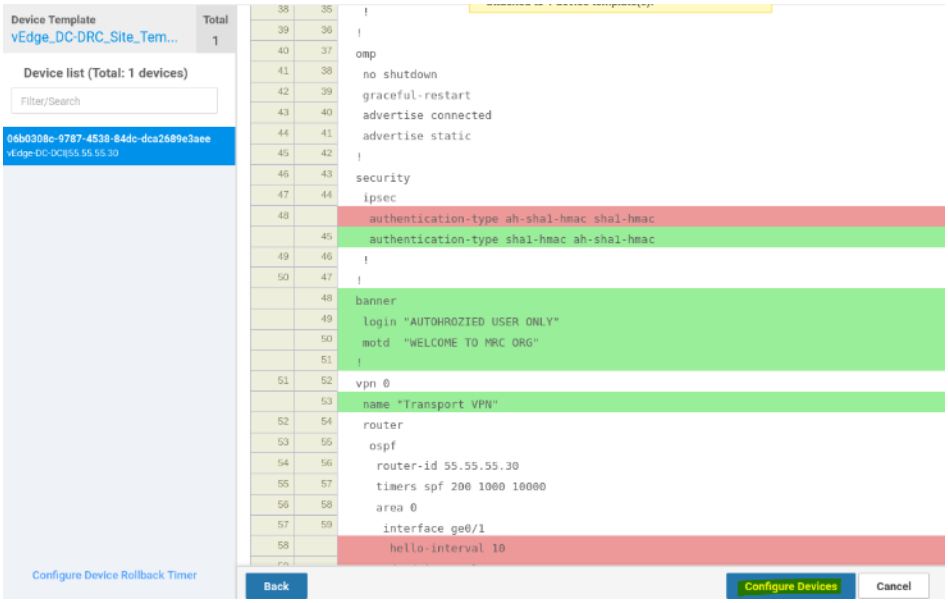
5. **[vEdge-DC-DCI]**



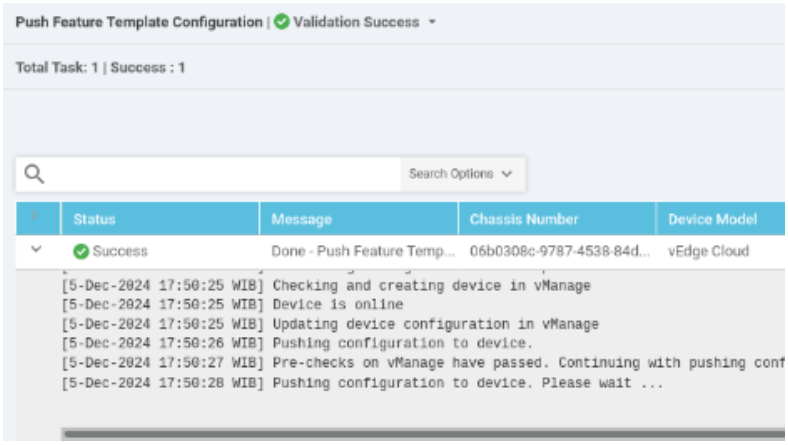
6. Click ‘Update’, then ‘Next’, and we can review the changes before applying them.



7. Once confirmed, select ‘Configure Devices’.



8. The Device template is successfully pushed to the selected devices.


Push Feature Template Configuration | Validation Success
Total Task: 1 | Success : 1
Search Options
Status
Message
Chassis Number
Device Model
Success
Done - Push Feature Temp...
06b0308c-9787-4538-84d...
vEdge Cloud
[5-Dec-2024 17:50:25 WIB] Checking and creating device in vManage
[5-Dec-2024 17:50:25 WIB] Device is online
[5-Dec-2024 17:50:25 WIB] Updating device configuration in vManage
[5-Dec-2024 17:50:26 WIB] Pushing configuration to device.
[5-Dec-2024 17:50:27 WIB] Pre-checks on vManage have passed. Continuing with pushing conf
[5-Dec-2024 17:50:28 WIB] Pushing configuration to device. Please wait ...

4. Verification Pushed Device Template

// Configuration > Device, the mode of both devices becomes 'vManage', meaning they are configured through vManage, with the Device template shown.

Hostname	System IP	Site ID	Mode	Assigned Template	Device Status
vEdge-PLG2	55.55.55.51	50	CLI	--	In Sync
vEdge-PLG3	55.55.55.52	50	CLI	--	In Sync
vEdge-PLG1	55.55.55.50	50	CLI	--	In Sync
vEdge-BDG2	55.55.55.41	40	CLI	--	In Sync
vEdge-DC-DCI	55.55.55.30	30	vManage	vEdge_DC-DRC_Site_Te...	In Sync
vEdge-DRC-Cyber2	55.55.55.20	20	vManage	vEdge_DC-DRC_Site_Te...	In Sync
vEdge-HO	55.55.55.1	1	CLI	--	In Sync
vEdge-BDG1	55.55.55.40	40	CLI	--	In Sync

// vEdge-DC-DCI

```
banner
 login "AUTOHROZIED USER ONLY"
 motd  "WELCOME TO MRC ORG"
!
vpn 0
 name "Transport VPN"
 router
  ospf
   router-id 55.55.55.30
   timers spf 200 1000 10000
   area 0
    interface ge0/1
     network point-to-point
    exit
   exit
  !
 !
```

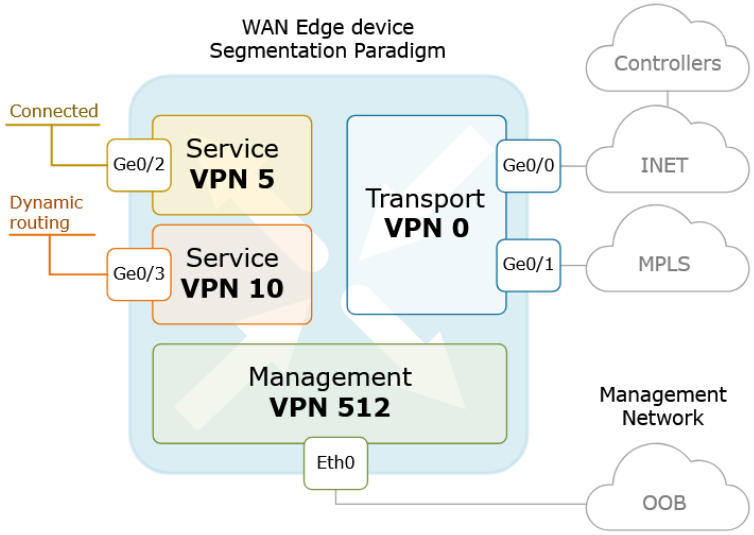
// vEdge-DRC-Cyber2 (Configured vManaged banner and OSPF)

```
banner
 login "AUTOHROZIED USER ONLY"
 motd  "WELCOME TO MRC ORG"
!
vpn 0
 name "Transport VPN"
 router
  ospf
   router-id 55.55.55.20
   timers spf 200 1000 10000
   area 0
    interface ge0/0
     network point-to-point
    exit
   exit
  !
 !
```

SERVICE VPN OVERVIEW: CONNECTED & STATIC ROUTES

Via CLI and Templates

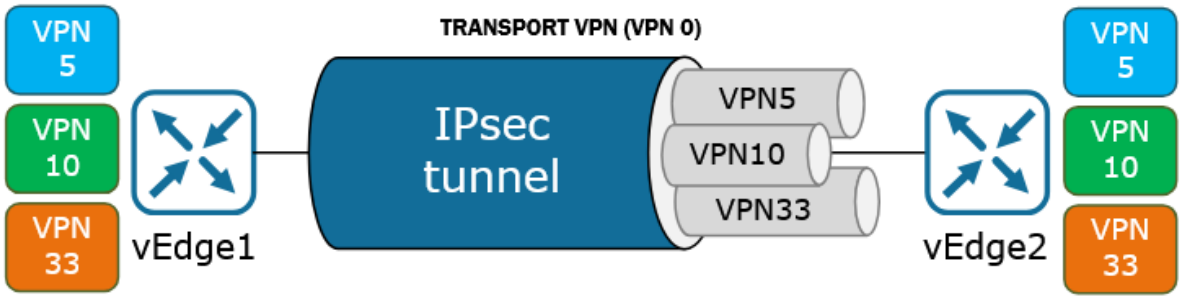
Service VPN in SD-WAN is similar to Virtual Routing Forwarding (VRF) in traditional networks. Each VPN/VRF has its own routing table, just like the segmentation done by VLAN (Layer 2), but here VPNs perform segmentation on the routing table (Layer 3).



Source: https://www.networkacademy.io/ccie-enterprise/sdwan/vpn-segmentation

Operationally, all controllers and vEdges are connected to each other, both from the controller to vEdge (DTLS tunnel) and from vEdge to vEdge (IPsec tunnel). All of these interconnections run on **VPN 0 / Transport VPN**, and all matters related to control plane/routing and security are handled via VPN 0.

All interfaces facing the transport link (such as MPLS/Internet) are part of the Transport VPN. They belong to their own local routing table, which we can refer to as the 'WAN Facing' routing table, while the interfaces behind the vEdge are referred to as 'LAN Facing'. All connectivity between these 'WAN Facing' interfaces occurs on VPN 0. **What makes SD-WAN shine is its ability to take all the Service VPN prefixes behind a vEdge and immediately forward them to the Service VPNs on another vEdge.**



Service VPN does not know how the packets are sent; all packet forwarding is handled by the Transport VPN**. The interconnection of Service VPNs behind the vEdge router is done just like in traditional networks, such as:**

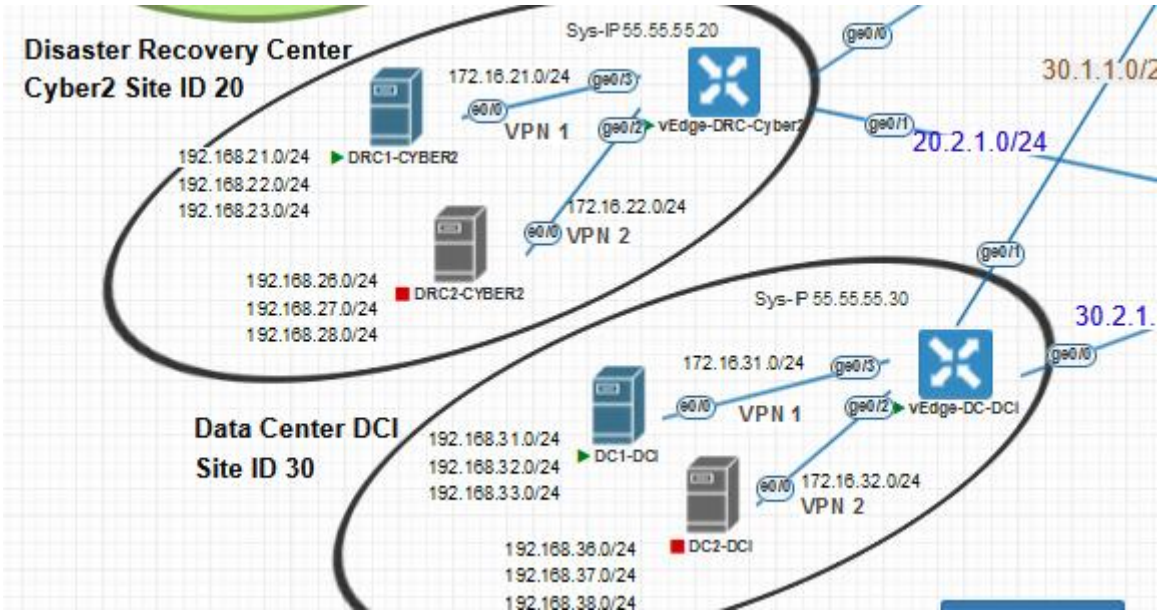
1. **Connected Routes**
2. **Static Routes**
3. **Dynamic Routes (OSPF, BGP, EIGRP, dsb)**

The most important thing is that the vEdge has interconnection to each prefix behind it (LAN Facing), whether using Static or Dynamic Routes. So, for example, when VPN 5 from vEdge1 wants to send a packet to VPN 5 on vEdge 2, the packet does not land on the 'WAN Facing/VPN 0' interface but directly to the 'LAN Facing/VPN 5' interface of vEdge 2.

In essence, the SD-WAN solution takes the routes behind the vEdge and sends them securely via OMP so that other vEdges can learn them. These are not routed via OMP; OMP is simply the control plane that forwards information from one side to the other to allow vEdges to learn the advertised routes.

However, remember that the control plane is not directly connected between vEdge to vEdge. The control plane connects vEdge to vSmart, then vSmart to vEdge (vEdge > vSmart > vEdge). **vSmart holds all the advertised routes for each Service VPN and forwards them to the target Service VPN of each vEdge.**

Scenario:



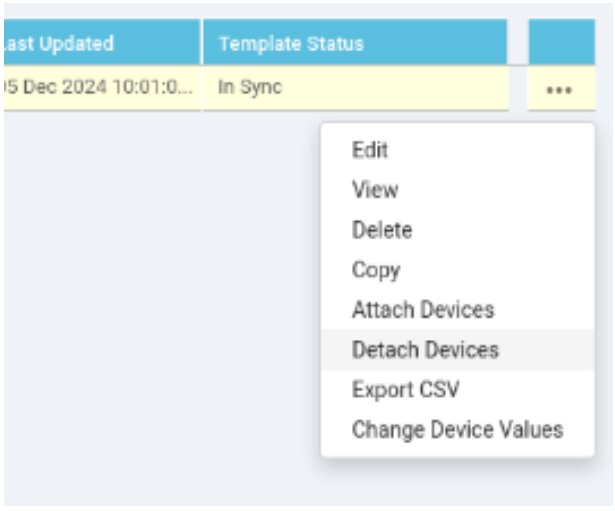
We will use a scenario between vEdge-DRC-Cyber2 (via CLI) and vEdge-DC-DCI (via Templates) for VPN1

VPN 1 : Connected Routes (CLI and Templates)

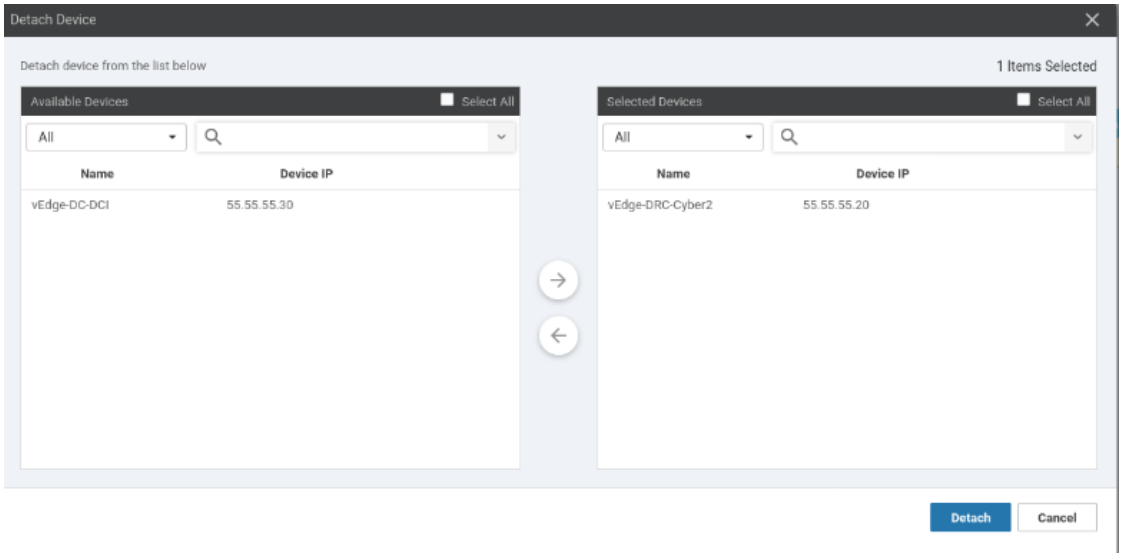
// via CLI

1. **[vEdge-DRC-Cyber2]**

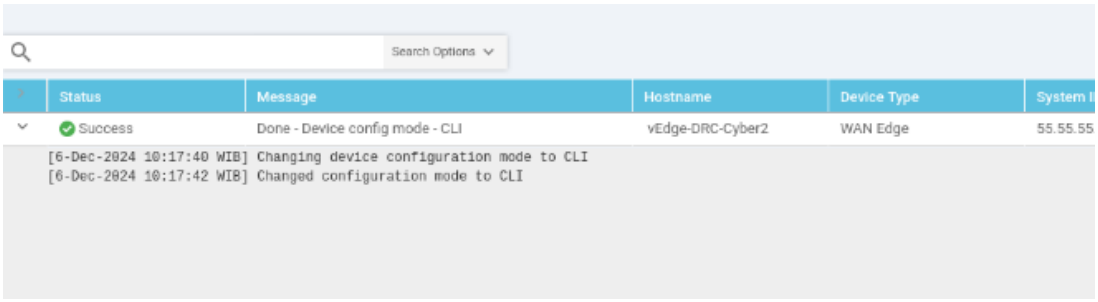
   Since this device was previously part of a Device Template, we can no longer configure it via CLI. First, detach the device. Go to Configuration > Template, then select the '...' on the far right.



Move the device to the right, then 'Detach.'



This will return vEdge-DRC-Cyber2 to CLI mode.



2. Create VPN 1 on vEdge-DRC-Cyber2, and enter the IP address as per the topology:

```
vpn 1
 interface ge0/3
  ip address 172.16.21.1/24
  no shutdown
 !
commit
!
```

3. Setup the 'DRC1-CYBER2' device (LAN Facing Device).

```
DRC1-CYBER2(config)#do show ip int br | exclude unassign
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            172.16.21.10    YES manual up                    up
Loopback1              192.168.21.10   YES manual up                    up
Loopback2              192.168.22.10   YES manual up                    up
Loopback3              192.168.23.10   YES manual up                    up

DRC1-CYBER2(config)#ip route 0.0.0.0 0.0.0.0 172.16.21.1
```

4. As a result, directly connected routes (172.16.21.0/24) will be automatically advertised by vEdge within VPN 1. We can see on show omp peers, there are 2 routes sent to vSmart.

```
vEdge-DRC-Cyber2# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-------------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:00:28:10       0/0/2
55.55.10.4      vsmart  1         1         10        up       0:00:28:10       0/0/2
```

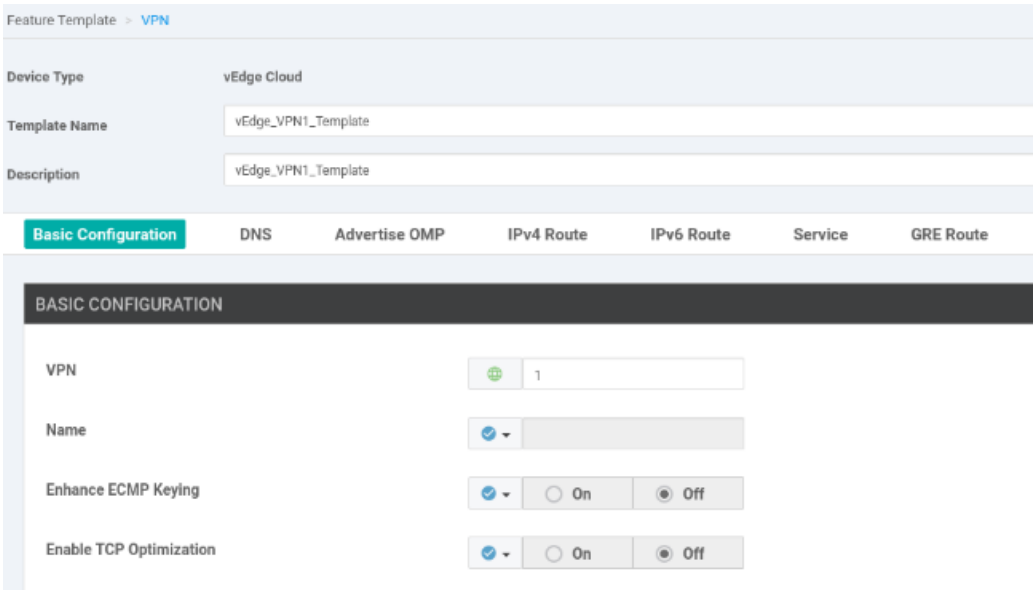
5. From the vSmart perspective, they receive routes from vEdge 55.55.55.20 and also send 2 routes to other vSmart devices.

```
vSmart1# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-------------------------------------------------------------------------------------
55.55.10.4      vsmart  1         1         10        up       0:00:44:01       2/0/2
55.55.55.20     vedge   1         1         20        up       0:00:30:10       2/0/0
55.55.55.30     vedge   1         1         30        up       0:00:41:52       0/0/0
```

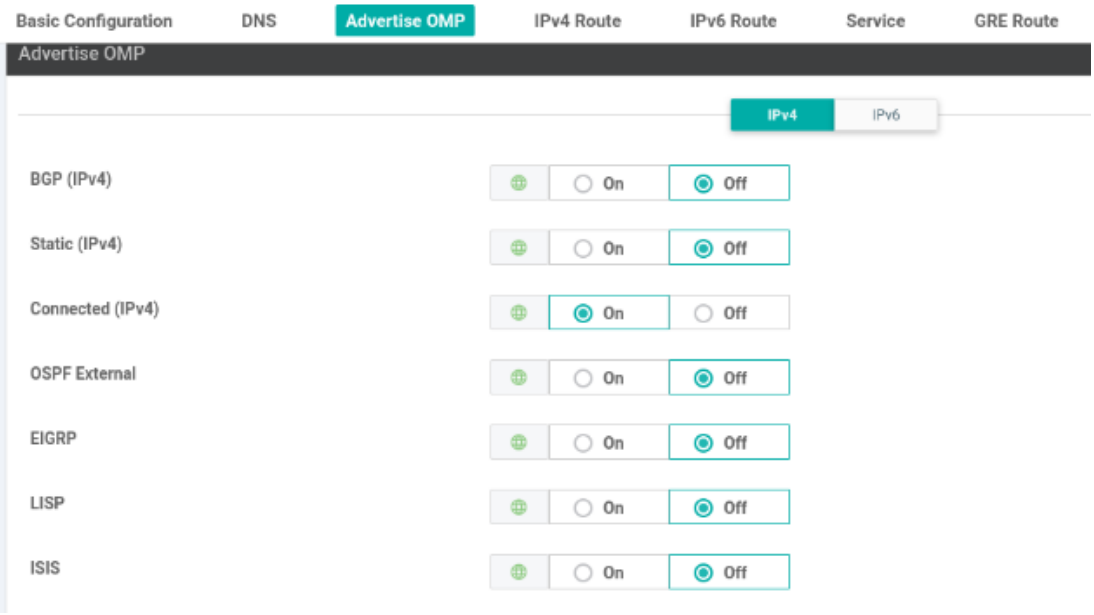
// via Templates

1. **[vEdge-DC-DCI]**

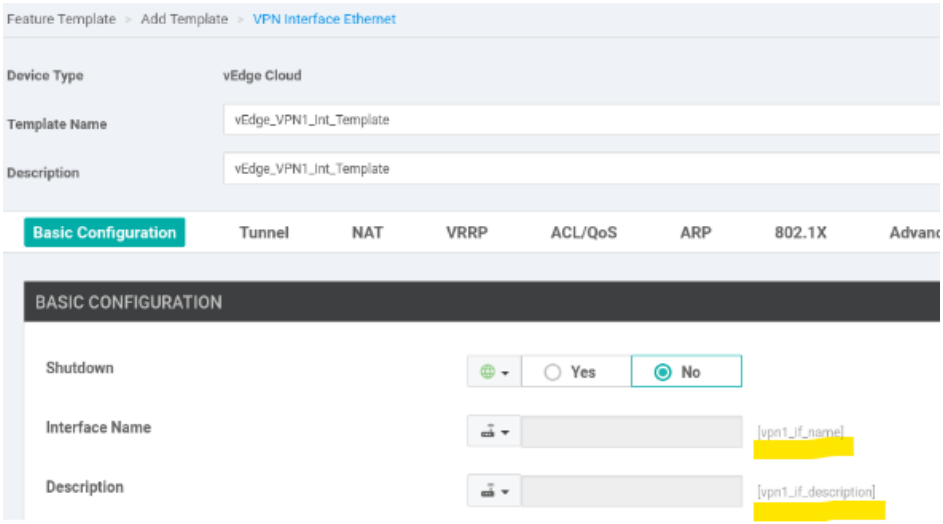
   Here, we will add a new feature template for the interface that connects to VPN 1 (LAN Facing). Go to Configuration > Template, then 'Add Template' for VPN 1.



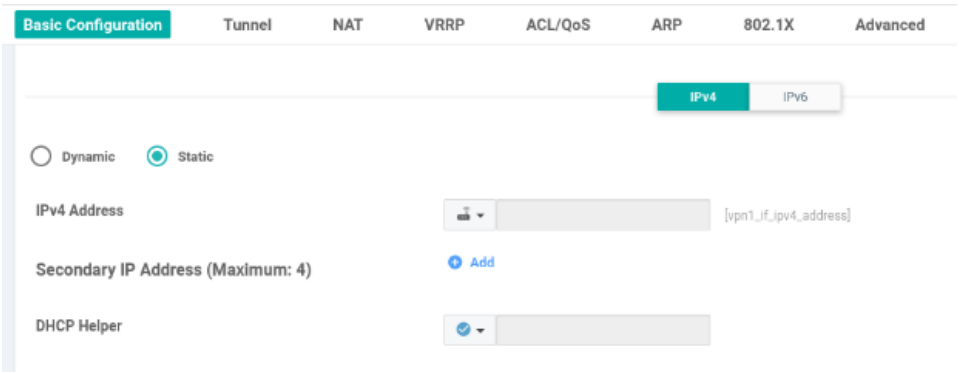
2. In the 'Advertise OMP' section, select On for 'Connected (IPv4),' then save.



3. Create another feature template for the VPN 1 Interface. Here, we use device-specific options for flexibility.



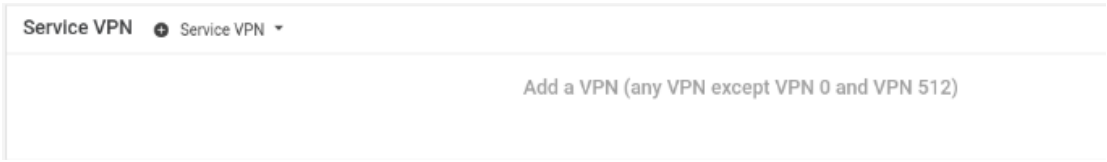
4. In 'IPv4,' select static, then create device-specific variables as follows, and save.



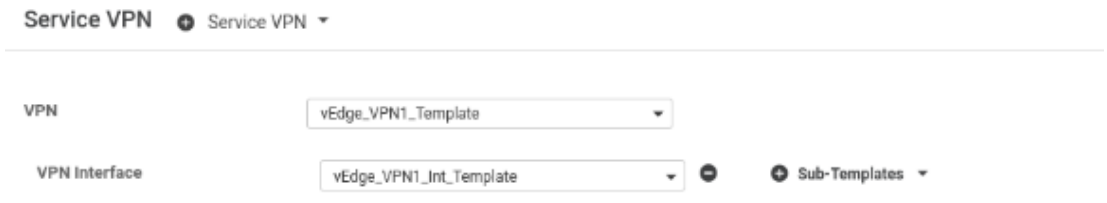
5. Add both the created feature templates to the device template.

vEdge_VPN1_Template	vEdge_VPN1_Template	WAN Edge VPN	vEdge Cloud
vEdge_VPN1_Int_Template	vEdge_VPN1_Int_Template	WAN Edge Interface	vEdge Cloud

6. Go to the Device Template 'vEdge_DC-DRC_Site_Template,' then edit. In the 'Service VPN' section, click '+' to add the feature template.

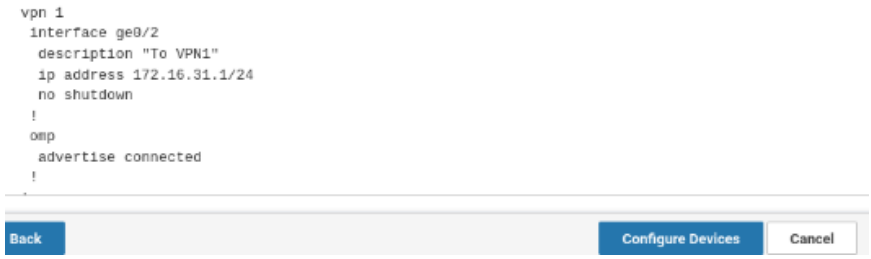


7. Add the VPN 1 feature template created earlier, then 'Update.'

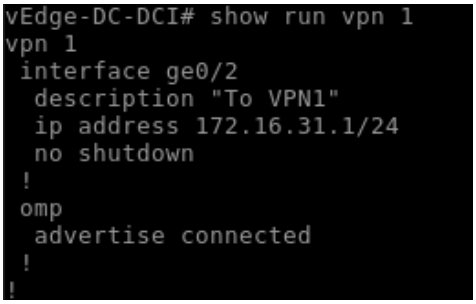


8. For device 'vEdge-DC-DCI,' perform 'Edit Device Template,' then fill in the information for VPN 1 at the bottom, then 'Update' and 'Next.'

9. Review the configuration that will be pushed to the device. If everything is correct, click 'Configure Device.'



10. As a result, the configuration will be successfully pushed to vEdge-DC-DCI.



11. Setup 'DC1-DCI' device

```
DC1-DCI(config)#do show ip int br | exclude unassi
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0/0            172.16.31.10    YES manual up                    up
Loopback1              192.168.31.10   YES manual up                    up
Loopback2              192.168.32.10   YES manual up                    up
Loopback3              192.168.33.10   YES manual up                    up

DC1-DCI(config)#ip route 0.0.0.0 0.0.0.0 172.16.31.1
```

// Verification VPN 1 Interconnection

1. #show omp peers

   Both devices receive, install, and send 2 routes.

```
vEdge-DC-DCI# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-----------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:01:24:19       2/2/2
```

```
vEdge-DRC-Cyber2# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-----------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:01:13:26       2/2/2
```

2. #show ip route

   There are 2 routes learned from VPN 1 via OMP, with 2 different transport links

```
vEdge-DRC-Cyber2# show ip route omp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                    PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN    PREFIX           PROTOCOL    SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-----------------------------------------------------------------------------------------------------------
1      172.16.31.0/24   omp         -         -           -                -        55.55.55.30      mpls
1      172.16.31.0/24   omp         -         -           -                -        55.55.55.30      public-internet
```

```
vEdge-DC-DCI# show ip route omp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                    PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN    PREFIX           PROTOCOL    SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-----------------------------------------------------------------------------------------------------------
1      172.16.21.0/24   omp         -         -           -                -        55.55.55.20      mpls
1      172.16.21.0/24   omp         -         -           -                -        55.55.55.20      public-internet
```

3. # ping & traceroute

```
DC1-DCI#ping 172.16.21.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.21.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 41/60/72 ms
DC1-DCI#tracer
DC1-DCI#traceroute 172.16.21.10
Type escape sequence to abort.
Tracing the route to 172.16.21.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.31.1 12 msec 11 msec 15 msec
  2 172.16.21.1 48 msec 52 msec 41 msec
  3 172.16.21.10 71 msec 72 msec *
```

```
DRC1-CYBER2#ping 172.16.31.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.31.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 55/68/72 ms
DRC1-CYBER2#trac
DRC1-CYBER2#traceroute 172.16.31.10
Type escape sequence to abort.
Tracing the route to 172.16.31.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.21.1 20 msec 14 msec 20 msec
  2 172.16.31.1 42 msec 43 msec 31 msec
  3 172.16.31.10 61 msec 69 msec *
```

VPN 1 : Static Routes (CLI and Templates)

// via CLI

1. **[vEdge-DRC-Cyber2]**

   Continuing from the previous step, we will add the static route on the LAN Facing segment, specifically from the DRC1-Cyber2 device.

2. Configure the static route to the DRC1-Cyber2 LAN segment:

```
vpn 1
!
 ip route 192.168.21.0/24 172.16.21.10
 ip route 192.168.22.0/24 172.16.21.10
 ip route 192.168.23.0/24 172.16.21.10
!
commit
```

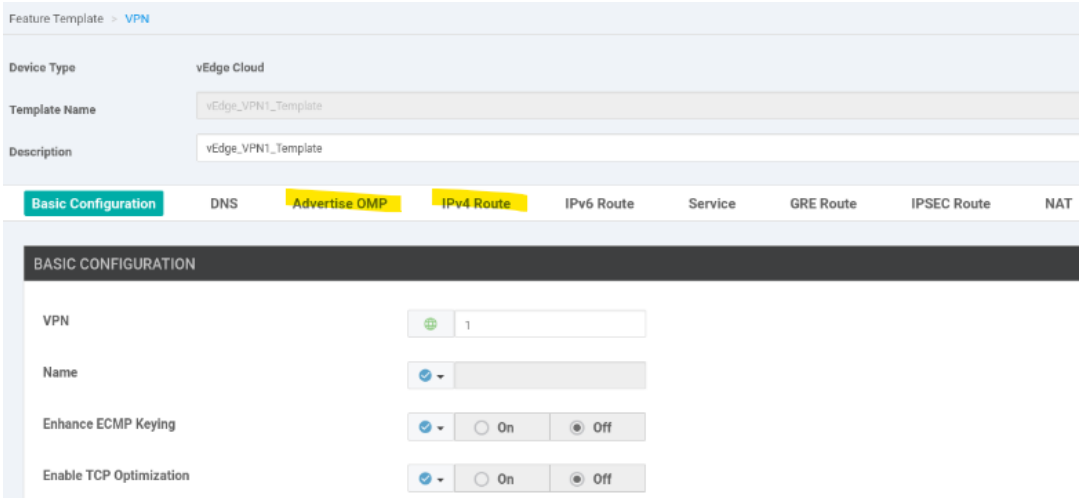
3. With this configuration, the static routes will automatically be advertised by vEdge within VPN 1. You can see in the show omp peers command, there are 8 routes (1 directly connected, 3 static routes, each with 2 transport links) being sent to vSmart.

```
vEdge-DRC-Cyber2# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-------------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:02:36:42       2/2/8
55.55.10.4      vsmart  1         1         10        up       0:02:36:42       2/0/8
```

// via Templates

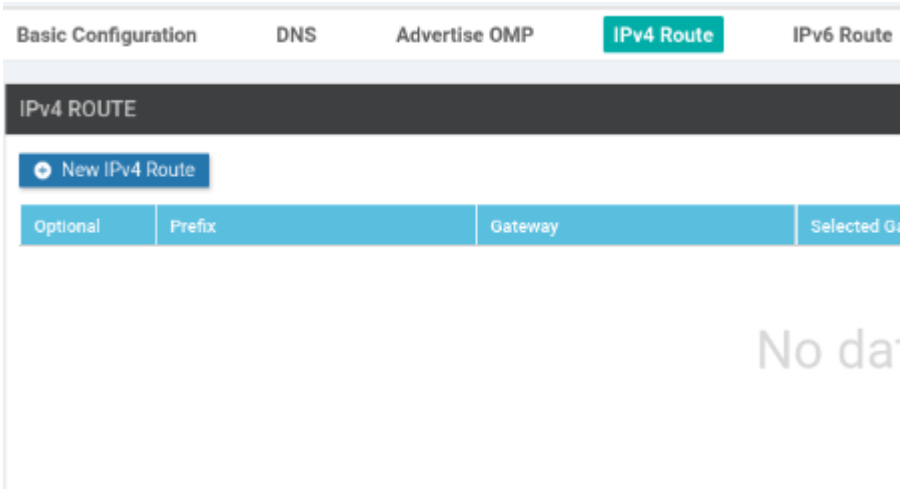
1. **[vEdge-DC-DCI]**

   Here, we will only edit the 'vEdge_VPN1_Template', specifically in the 'Advertise OMP' and 'IPv4 Route' sections

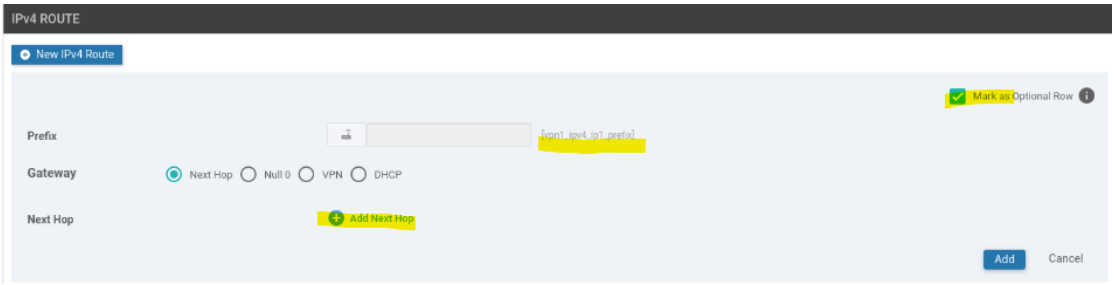


2. In 'Advertise OMP' section, select 'On' for both 'Connected (IPv4)' and 'Static (IPv4)'.

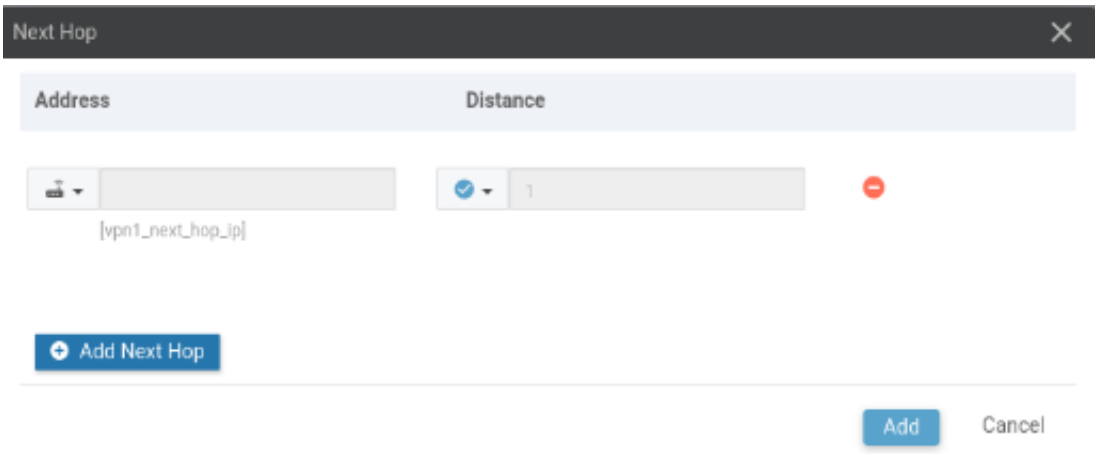
3. Then go to the 'IPv4 Route' section, click 'New IPv4 Route' to add the static IP route.



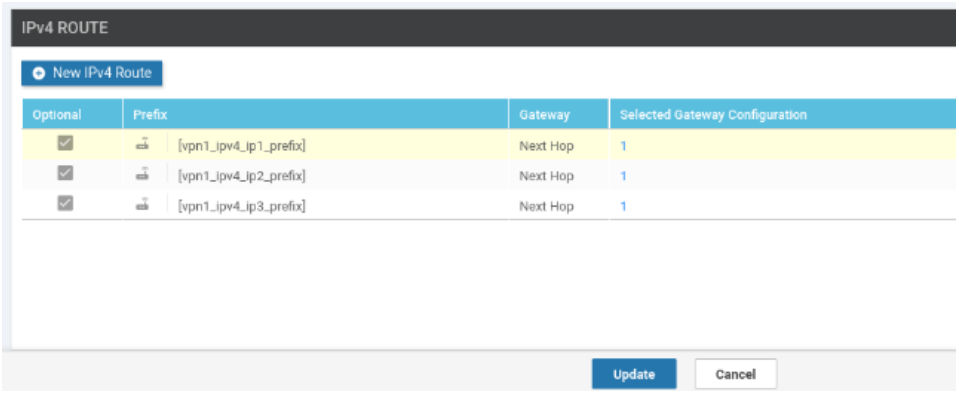
4. For the prefix, we will use device-specific variables as shown in the image, check 'Mark as Optional Row' to leave it empty if not needed, then click 'Add Next Hop' to add the next-hop address.



5. Choose the device-specific option for the next-hop address, then click 'Add'.

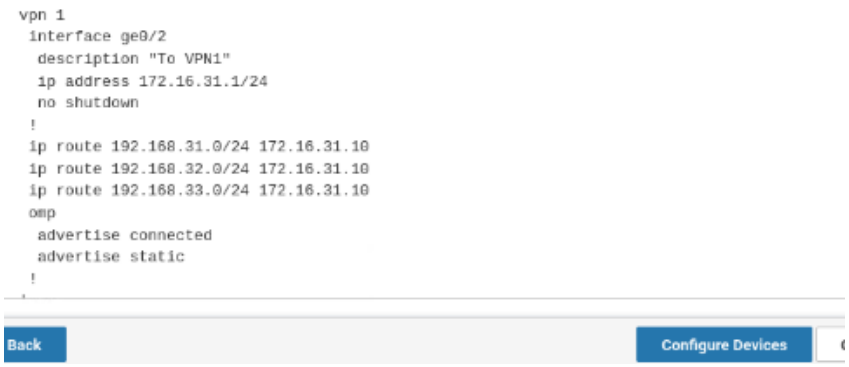


6. With this, the static route is successfully created. Repeat the above steps to create 3 static routes as per the scenario, then click ‘Update’.

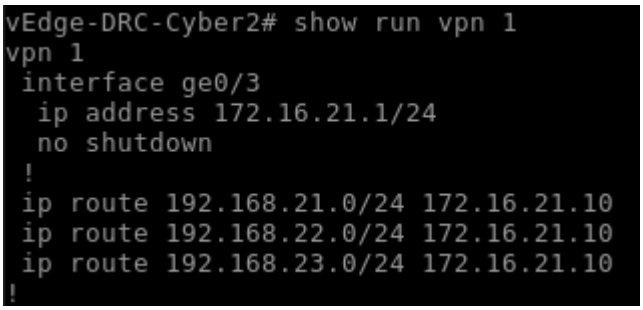


7. Add the values or information related to the static routes to ‘vEdge-DC-DCI’. Once done, click ‘Update’, then ‘Next’.

8. Verify the configuration to be pushed to the device. If correct, click ‘Configure Device’.



9. With that, the configuration is successfully pushed to vEdge-DC-DCI.



VPN 1 : Verification

// Directly Connected routes

1. #show omp peers

   Both devices receive, install, and send 2 routes.

```
vEdge-DC-DCI# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-------------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:01:24:19       2/2/2
```

```
vEdge-DRC-Cyber2# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-------------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:01:13:26       2/2/2
```

2. #show ip route omp

   There are 2 routes learned from VPN 1 via OMP, with 2 different transport links.

```
vEdge-DRC-Cyber2# show ip route omp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                    PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN    PREFIX           PROTOCOL    SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-------------------------------------------------------------------------------------------------------------
1      172.16.31.0/24   omp         -         -           -                -        55.55.55.30      mpls
1      172.16.31.0/24   omp         -         -           -                -        55.55.55.30      public-internet
```

```
vEdge-DC-DCI# show ip route omp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                    PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN    PREFIX           PROTOCOL    SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-------------------------------------------------------------------------------------------------------------
1      172.16.21.0/24   omp         -         -           -                -        55.55.55.20      mpls
1      172.16.21.0/24   omp         -         -           -                -        55.55.55.20      public-internet
```

3. # ping & traceroute

```
DC1-DCI#ping 172.16.21.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.21.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 41/60/72 ms
DC1-DCI#tracer
DC1-DCI#traceroute 172.16.21.10
Type escape sequence to abort.
Tracing the route to 172.16.21.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.31.1 12 msec 11 msec 15 msec
  2 172.16.21.1 48 msec 52 msec 41 msec
  3 172.16.21.10 71 msec 72 msec *
```

```
DRC1-CYBER2#ping 172.16.31.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.31.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 55/68/72 ms
DRC1-CYBER2#trac
DRC1-CYBER2#traceroute 172.16.31.10
Type escape sequence to abort.
Tracing the route to 172.16.31.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.21.1 20 msec 14 msec 20 msec
  2 172.16.31.1 42 msec 43 msec 31 msec
  3 172.16.31.10 61 msec 69 msec *
```

// Static routes

1. #show omp peers

```
vEdge-DRC-Cyber2# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-----------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:03:52:28       8/8/8
```

```
vEdge-DC-DCI# show omp peers
R -> routes received
I -> routes installed
S -> routes sent

                        DOMAIN    OVERLAY   SITE
PEER            TYPE    ID        ID        ID        STATE    UPTIME           R/I/S
-----------------------------------------------------------------------------------
55.55.10.3      vsmart  1         1         10        up       0:04:05:49       8/8/8
```

2. # show ip route omp

```
vEdge-DC-DCI# show ip route omp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                    PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN     PREFIX          PROTOCOL    SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-------------------------------------------------------------------------------------------------------------------
1       172.16.21.0/24  omp         -         -           -                -        55.55.55.20      mpls
1       172.16.21.0/24  omp         -         -           -                -        55.55.55.20      public-internet
1       192.168.21.0/24 omp         -         -           -                -        55.55.55.20      mpls
1       192.168.21.0/24 omp         -         -           -                -        55.55.55.20      public-internet
1       192.168.22.0/24 omp         -         -           -                -        55.55.55.20      mpls
1       192.168.22.0/24 omp         -         -           -                -        55.55.55.20      public-internet
1       192.168.23.0/24 omp         -         -           -                -        55.55.55.20      mpls
1       192.168.23.0/24 omp         -         -           -                -        55.55.55.20      public-internet
```

```
vEdge-DRC-Cyber2# show ip route omp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                    PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN     PREFIX          PROTOCOL    SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-------------------------------------------------------------------------------------------------------------------
1       172.16.31.0/24  omp         -         -           -                -        55.55.55.30      mpls
1       172.16.31.0/24  omp         -         -           -                -        55.55.55.30      public-internet
1       192.168.31.0/24 omp         -         -           -                -        55.55.55.30      mpls
1       192.168.31.0/24 omp         -         -           -                -        55.55.55.30      public-internet
1       192.168.32.0/24 omp         -         -           -                -        55.55.55.30      mpls
1       192.168.32.0/24 omp         -         -           -                -        55.55.55.30      public-internet
1       192.168.33.0/24 omp         -         -           -                -        55.55.55.30      mpls
1       192.168.33.0/24 omp         -         -           -                -        55.55.55.30      public-internet
```

3. # ping & traceroute

```
DRC1-CYBER2#ping 192.168.31.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.31.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 51/63/73 ms
DRC1-CYBER2#ping 192.168.32.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.32.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 51/69/80 ms
DRC1-CYBER2#ping 192.168.33.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.33.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 44/66/73 ms
DRC1-CYBER2#traceroute 192.168.33.10
Type escape sequence to abort.
Tracing the route to 192.168.33.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.21.1 20 msec 10 msec 18 msec
  2 172.16.31.1 52 msec 51 msec 51 msec
  3 172.16.31.10 61 msec 63 msec *
```

```
DC1-DCI#ping 192.168.21.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.21.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 61/70/82 ms
DC1-DCI#ping 192.168.22.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.22.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 59/65/72 ms
DC1-DCI#ping 192.168.23.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.23.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 63/69/72 ms
DC1-DCI#tracer
DC1-DCI#traceroute 192.168.23.10
Type escape sequence to abort.
Tracing the route to 192.168.23.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.31.1 15 msec 20 msec 20 msec
  2 172.16.21.1 41 msec 58 msec 51 msec
  3 172.16.21.10 72 msec 63 msec *
```

SERVICE VPN: VRRP & DHCP

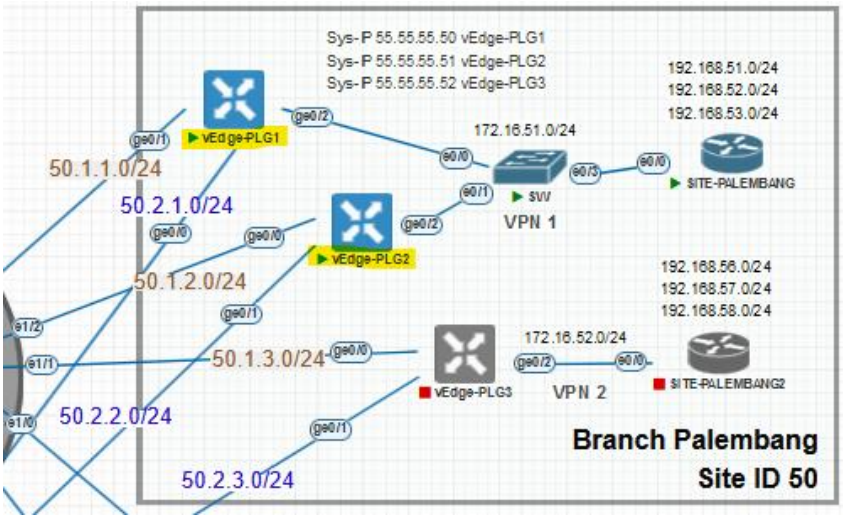
Via CLI and Templates

Scenario:

In this scenario, we will use the Palembang Site (Site 50), with vEdge-PLG1 and vEdge-PLG2. The features that we will apply here include:

1. Virtual Router Redundancy Protocol (VRRP)
2. Dynamic Host Configuration Protocol (DHCP)

The gateway used for each network in Service VPN 1 / LAN Facing is the IP from VRRP, and the interface leading to vEdge from the 'SITE-PALEMBANG' will use DHCP.



vEdge-PLG1 will be configured through CLI, while vEdge-PLG2 will be configured using templates. We will create a new Device Template for vEdge-PLG2, involving the feature templates that have been created, as follows:

- Basic Configuration > System
- VPN > VPN 0 (VPN (Default Route, OSPF), VPN Interface)
- VPN > VPN 512 (VPN, VPN Interface)
- VPN > VPN 1 (VPN, VPN Interface) << we have not yet applying routing protocol
- Other Template > Banner

VPN 1 : VRRP (CLI and Templates)

// via CLI

1. **[vEdge-PLG1]**
2. Set up VPN 1 and configure VRRP on interface Ge0/2 (LAN Facing)

```
vpn 1
 interface ge0/2
  ip address 172.16.51.1/24
  no shutdown
  vrrp 50
   priority  200
   track-omp                    << if there is problem with omp, the priority decreased
   ipv4 172.16.51.25
  !
commit
 !
```

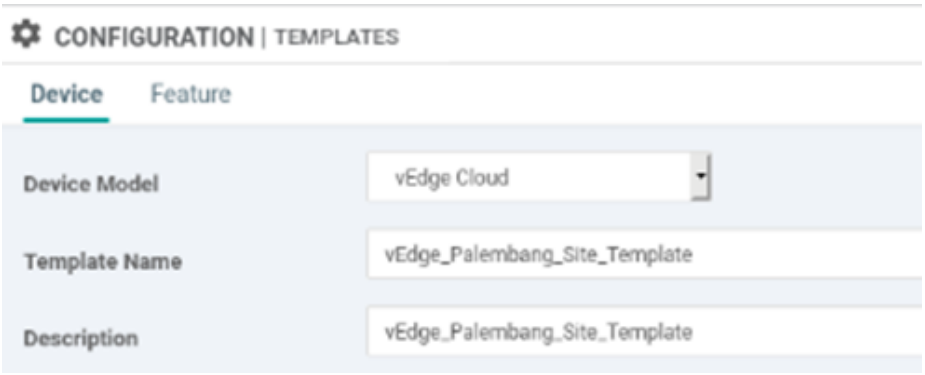
// via Templates

1. **[vEdge-PLG2]**

   Copy feature templates for VPN 0 and VPN 1 for the Palembang Site and remove the template configuration used previously for DC & DRC, to ensure that the configuration for the DC & DRC device templates is not disturbed.

vEdge_PLG_VPN0_Int_Ge0/0_Template	vEdge_PLG_VPN0_Int_Ge0/...	WAN Edge Interface
vEdge_PLG_VPN0_Int_Ge0/1_Template	vEdge_PLG_VPN0_Int_Ge0/...	WAN Edge Interface
vEdge_PLG_VPN0_Template	vEdge_PLG_VPN0_Template	WAN Edge VPN
vEdge_PLG_VPN1_Int_Template	vEdge_PLG_VPN1_Int_Tem...	WAN Edge Interface
vEdge_PLG_VPN1_Template	vEdge_PLG_VPN1_Template	WAN Edge VPN

2. Create a new device template for the Palembang Site..

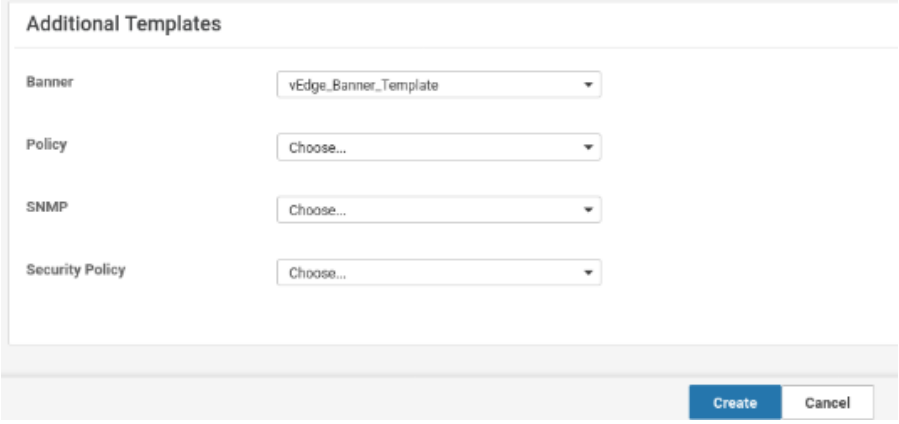


3. Basic Configuration

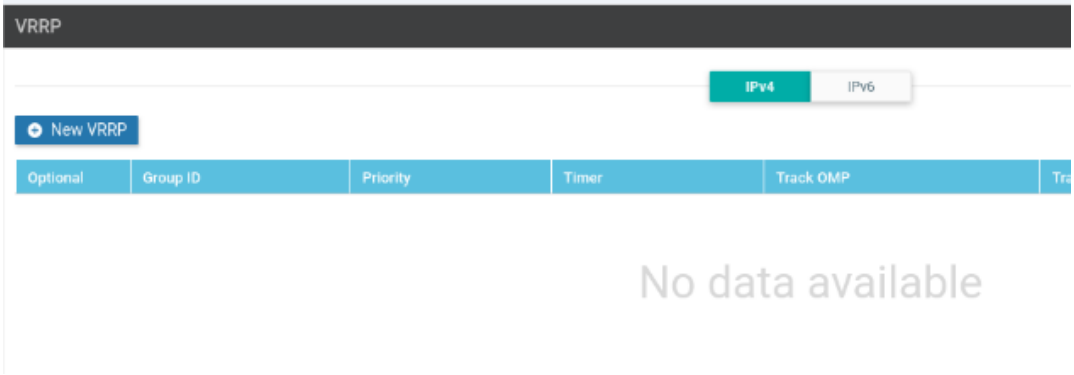
4. Transport & Management VPN

5. Service VPN

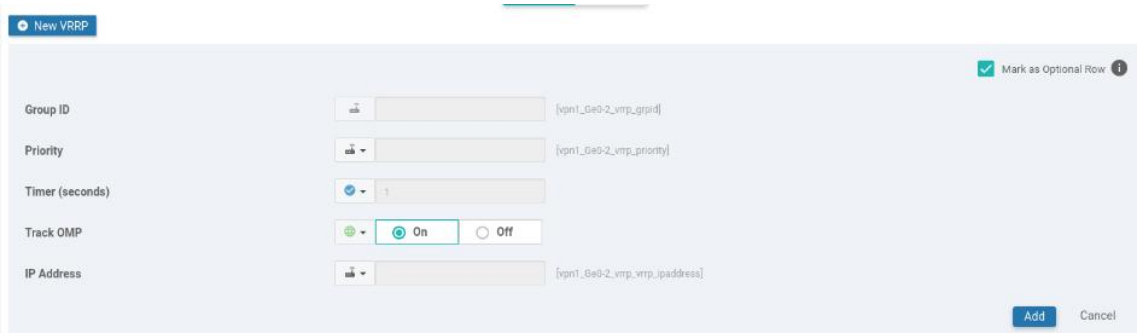
6. Addional Templates, then 'Create'



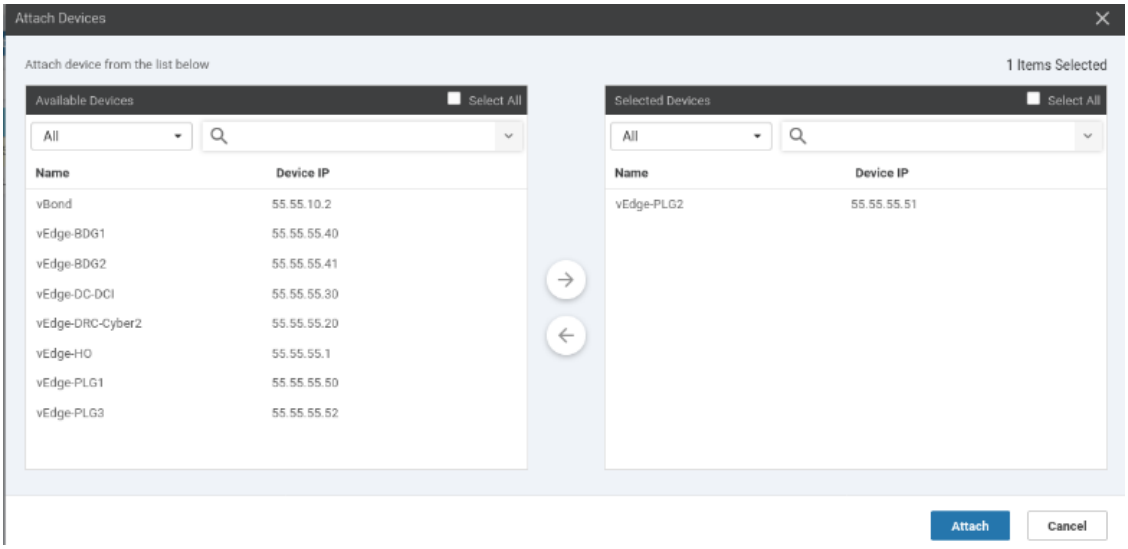
7. **Configure VRRP** on interface Ge0/2 (LAN Facing) on VPN 1. Go to the feature template for VPN 1 Interface, then go to the 'VRRP' section.



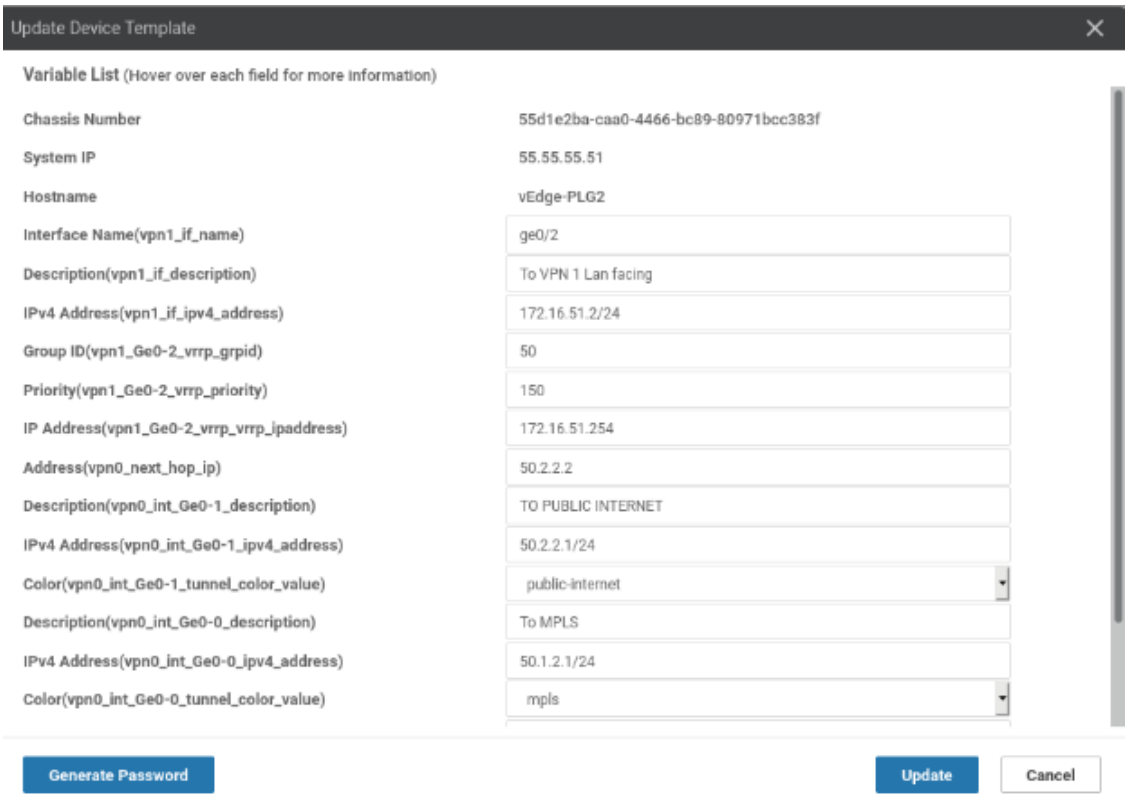
8. Click 'New VRRP', then make all parameters device-specific. We will configure them when attaching to the device, then click 'Add' and 'Update'.



9. Attach the device to the device template that has been created.

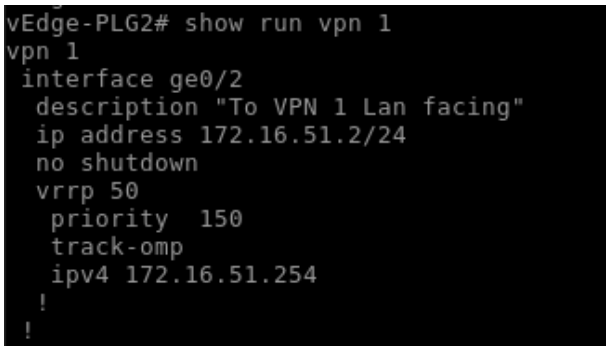


10. Edit all parameter values according to the topology. For VRRP, we will make vEdge-PLG1 the backup VRRP, so we set its priority to 150. Once all fields are filled, click 'Update'.



11. Verify the configuration preview before pushing. If everything is correct, click 'Configure Device'.

12. The configuration is successfully pushed to vEdge-PLG2.



VPN 1 : DHCP (CLI and Templates)

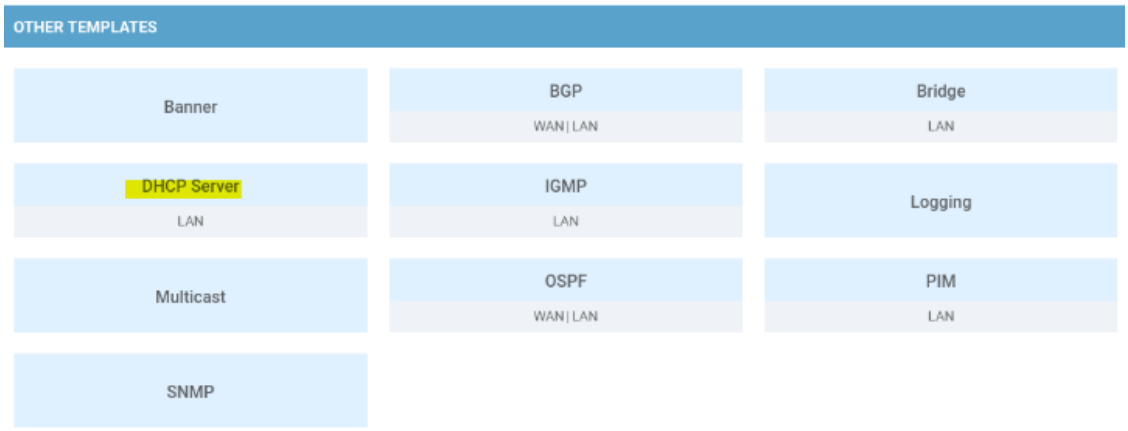
// via CLI

1. **[vEdge-PLG1]**
2. Configure DHCP on VPN 1 interface Ge0/2 (LAN Facing)

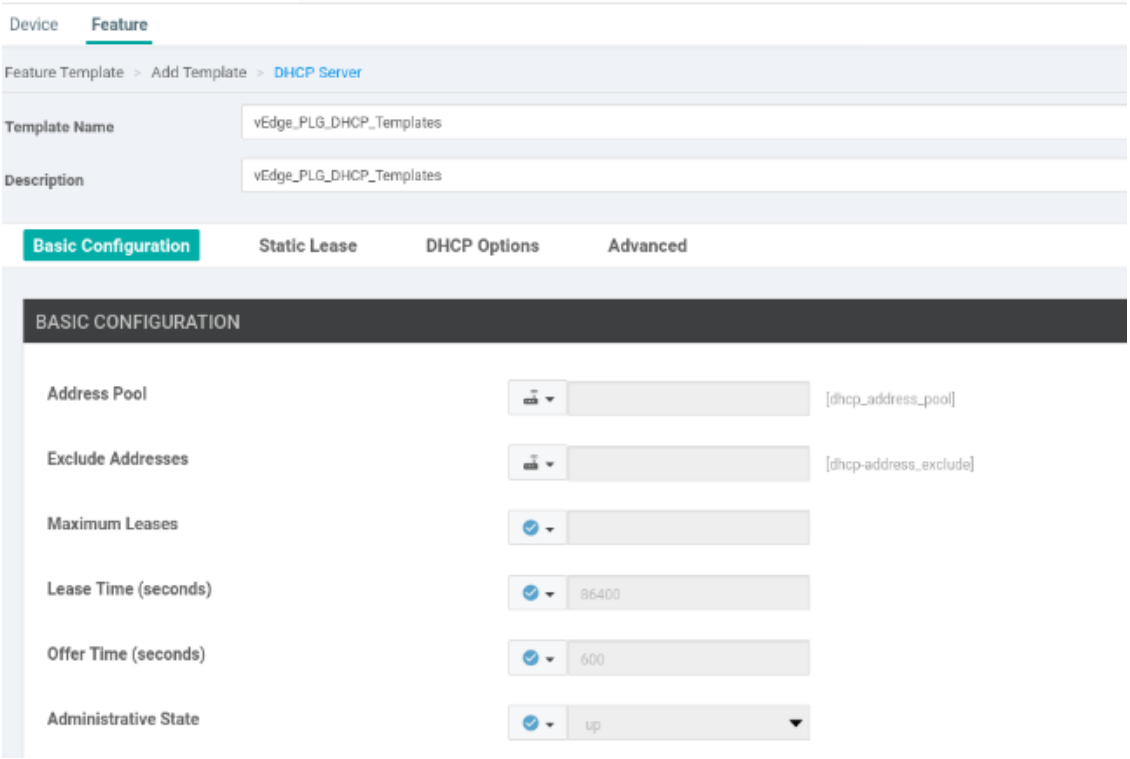
```
vpn 1
 interface ge0/2
  dhcp-server
   address-pool 172.16.51.0/24
   exclude     172.16.51.1 172.16.51.2 172.16.51.254
   options
    default-gateway 172.16.51.254
    dns-servers    8.8.8.8
   !
```

// via Templates

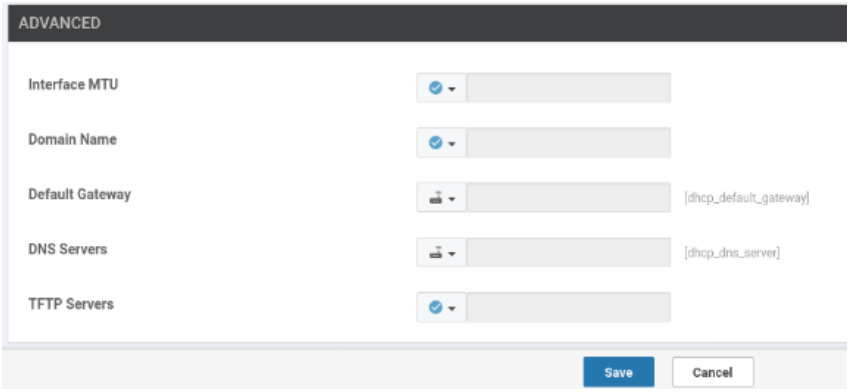
1. **[vEdge-PLG2]**
2. Add a new feature template, Other Template > DHCP



3. Create template name and choose device-specific option for address pool and exclusions

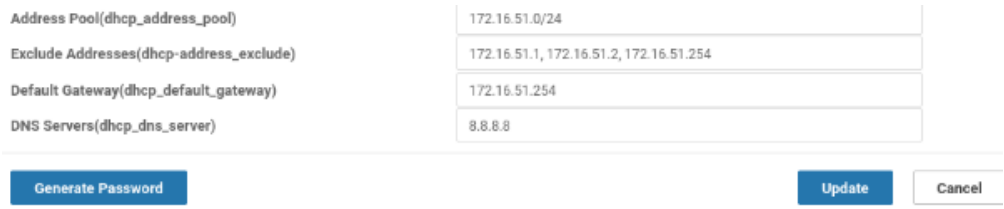


4. In the ‘Advanced’ section, choose device-specific options for ‘Default gateway’ and ‘DNS Server’ which will be configured later, then save.



5. Apply DHCP to the Palembang Site device template, in the ‘Service VPN’ section, specifically in the VPN 1 Interface template. Add ‘Sub-templates’ and input the DHCP-Server template that has been created, then click ‘Update’.

6. On vEdge-PLG2, ‘Edit Device Template’ then fill in the necessary DHCP information, finally click ‘Update’ and ‘Next’.



7. Verify the configuration before pushing to the device, and if everything looks good, click ‘Configure Devices’.

8. The configuration is successfully pushed to ‘vEdge-PLG2’.

```
vpn 1
 interface ge0/2
  description "To VPN 1 Lan facing"
  ip address 172.16.51.2/24
  no shutdown
  vrrp 50
   priority  150
   track-omp
   ipv4 172.16.51.254
  !
  dhcp-server
   address-pool 172.16.51.0/24
   exclude      172.16.51.1 172.16.51.2 172.16.51.254
   offer-time   600
   lease-time   86400
   admin-state  up
   options
    default-gateway 172.16.51.254
    dns-servers     8.8.8.8
   !
  !
 !
!
```

VPN 1 : Verification

show vrrp

```
vEdge-PLG1# show vrrp
vrrp vpn 1
 interfaces ge0/2
  groups 50
   virtual-ip              172.16.51.254
   virtual-mac             00:00:5e:00:01:32
   priority                200
   vrrp-state              master
   omp-state               up
   advertisement-timer     1
   master-down-timer       3
   last-state-change-time 2024-12-07T09:08:10+00:00
```

```
vEdge-PLG2# show vrrp
vrrp vpn 1
 interfaces ge0/2
  groups 50
   virtual-ip              172.16.51.254
   virtual-mac             00:00:5e:00:01:32
   priority                150
   vrrp-state              backup
   omp-state               up
   advertisement-timer     1
   master-down-timer       3
   last-state-change-time 2024-12-07T02:16:53+00:00
```

DHCP Request from 'SITE-PALEMBANG' device

```
SITE-PALEMBANG(config)#int e0/0
SITE-PALEMBANG(config-if)#ip add
SITE-PALEMBANG(config-if)#ip address dhcp
SITE-PALEMBANG(config-if)#no shut
SITE-PALEMBANG(config-if)#do show ip
*Dec  7 03:02:55.728: %LINK-3-UPDOWN: Interface Ethernet0/0, changed state to up
*Dec  7 03:02:56.730: %LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0/0, changed state to up
SITE-PALEMBANG(config-if)#do show ip int br
*Dec  7 03:03:01.432: %DHCP-6-ADDRESS_ASSIGN: Interface Ethernet0/0 assigned DHCP address 172.16.51.171, mask 255.255.255.0,

SITE-PALEMBANG(config-if)#do show ip int br
Interface                  IP-Address      OK? Method Status                Protocol
Ethernet0/0                172.16.51.171   YES DHCP   up                    up
Ethernet0/1                unassigned      YES unset  administratively down down
Ethernet0/2                unassigned      YES DHCP   administratively down down
Ethernet0/3                unassigned      YES unset  administratively down down
Ethernet1/0                unassigned      YES unset  administratively down down
Ethernet1/1                unassigned      YES unset  administratively down down
Ethernet1/2                unassigned      YES unset  administratively down down
Ethernet1/3                unassigned      YES unset  administratively down down
Loopback1                  192.168.51.10   YES manual up                    up
Loopback2                  192.168.52.10   YES manual up                    up
Loopback3                  192.168.53.10   YES manual up                    up
```

```
vEdge-PLG1# show dhcp server
dhcp server vpn 1 ge0/2
 bindings aa:bb:cc:00:0b:00
  client-ip              172.16.51.171
  lease-time             1:00:00:00
  lease-time-remaining 0:23:58:03
  static-binding         false
  host-name              SITE-PALEMBANG
```

VRRP Test

```
SITE-PALEMBANG#traceroute 192.168.21.10
Type escape sequence to abort.
Tracing the route to 192.168.21.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.51.1 20 msec 21 msec 20 msec
  2 172.16.21.1 53 msec 42 msec 51 msec
  3  *
     172.16.21.10 48 msec *
```

vEdge-PLG1 Master

```
vEdge-PLG1(config-interface-ge0/2)# int ge0/2
vEdge-PLG1(config-interface-ge0/2)# shutdown
vEdge-PLG1(config-interface-ge0/2)# commit
```

Shutdown Master VRRP

```
vrrp vpn 1
 interfaces ge0/2
  groups 50
   virtual-ip             172.16.51.254
   virtual-mac            00:00:5e:00:01:32
   priority               150
   vrrp-state             master
   omp-state              up
   advertisement-timer    1
   master-down-timer      3
   last-state-change-time 2024-12-07T03:07:59+00:00
```

vEdge-PLG2 takeover Master role

```
SITE-PALEMBANG#traceroute 192.168.21.10
Type escape sequence to abort.
Tracing the route to 192.168.21.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.51.2 21 msec 21 msec 20 msec
  2 172.16.21.1 42 msec 51 msec 51 msec
  3 172.16.21.10 71 msec *  69 msec
```

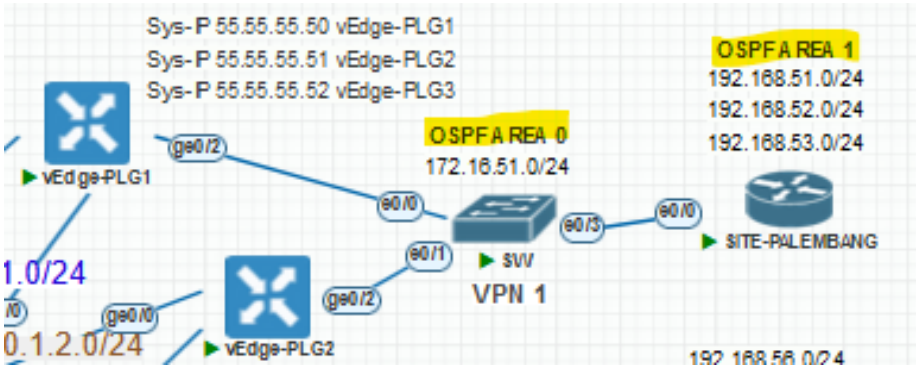
vEdge-PLG2 Master

SERVICE VPN: OSPF CONFIGURATION

Via CLI and Templates

Scenario:

In the interconnection of Service VPN 1 or LAN Facing, we will connect each segment using OSPF, building neighbor peering between the vEdge-PLG device and SITE-PALEMBANG. Here, we will use the **default OSPF network type**, which is **Broadcast**, so there will be **Type 2 LSA** or Network LSA that function as DR/BDR packets both during the election process and in operation.



The segments connected to the switches between the three devices mentioned above are included in OSPF area 0, while the loopback address or the segment behind the 'SITE-PALEMBANG' device is included in OSPF area 1. We will configure the connectivity of Service VPN 1 with OSPF, where the vEdge-PLG1 device will configure it via CLI, and vEdge-PLG2 will do it through vManage/Templates.

Setup LAN Facing Device

1. **[SITE-PALEMBANG]**
2. Configure OSPF to establish a neighborship with vEdge so that the prefixes on SITE-PALEMBANG will be advertised to VPN 1

```
router ospf 1
 router-id 50.50.50.100
```

```
 network 0.0.0.0 255.255.255.255 area 0
!
Interface range lo1-3
 ip ospf network point-to-point
!
```

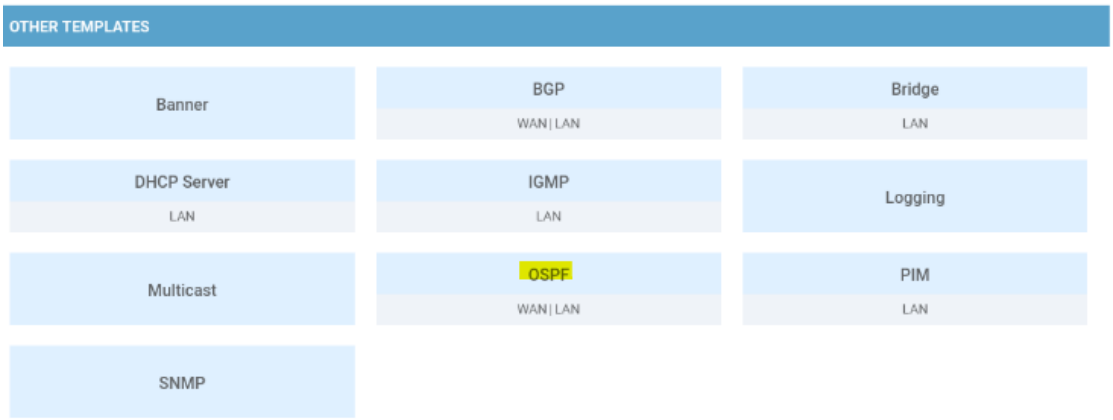
VPN 1 : OSPF PEERING VIA CLI

1. **[vEdge-PLG1]**
2. Configure OSPF with default-information originate to redistribute the default route to the public internet, then use redistribute omp to allow 'SITE-PALEMBANG' to receive prefixes from OMP from other sites. Define OSPF area 0 on interface ge0/2 (LAN Facing). Apply a cost of 5 to make vEdge-PLG1 the primary link for OSPF (according to its VRRP role).

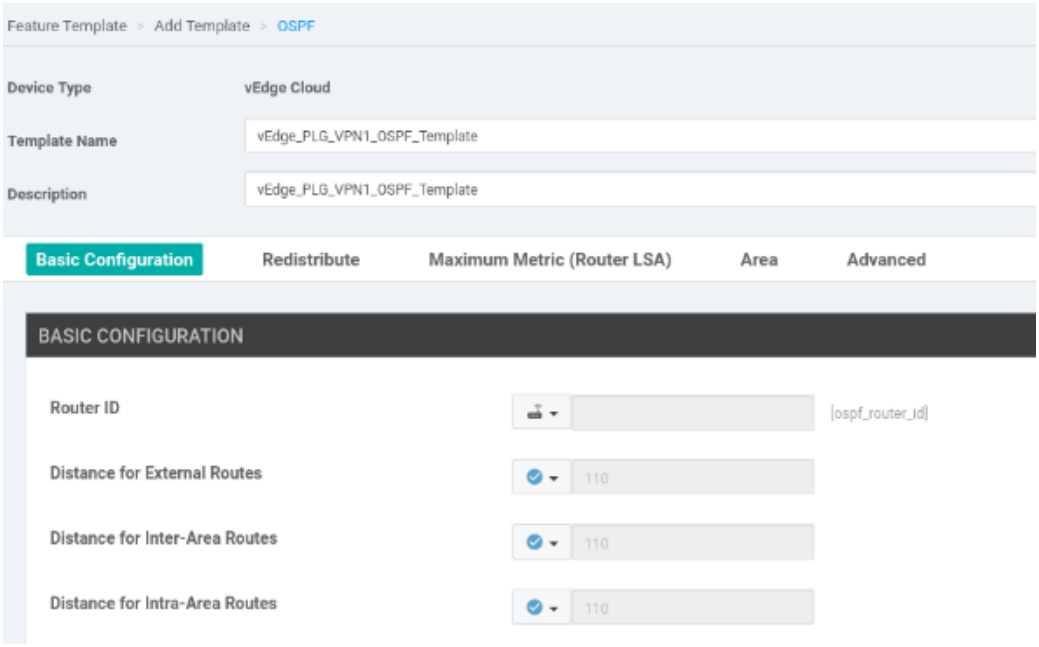
```
vpn 1
 router
  ospf
   router-id 55.55.55.50
   default-information originate
   redistribute omp
   area 0
    interface ge0/2
     cost 5
    exit
   exit
  !
commit
 !
```

VPN 1 : OSPF PEERING VIA TEMPLATES

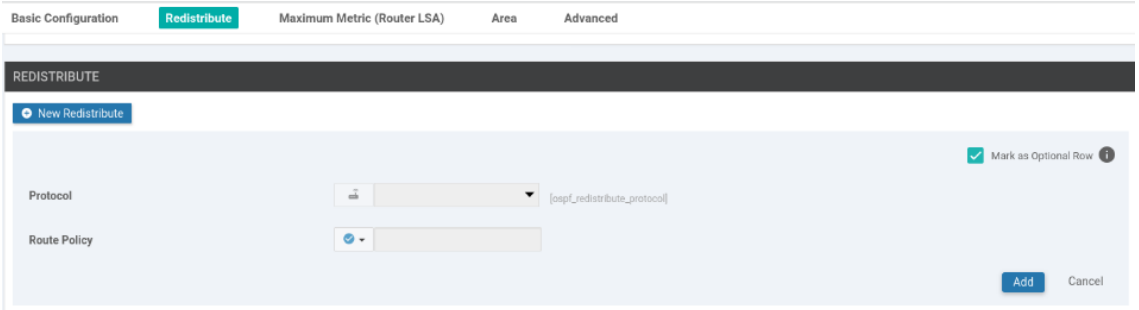
1. **[vEdge-PLG2]**
2. Create a new feature template for OSPF to be applied to Service VPN 1.



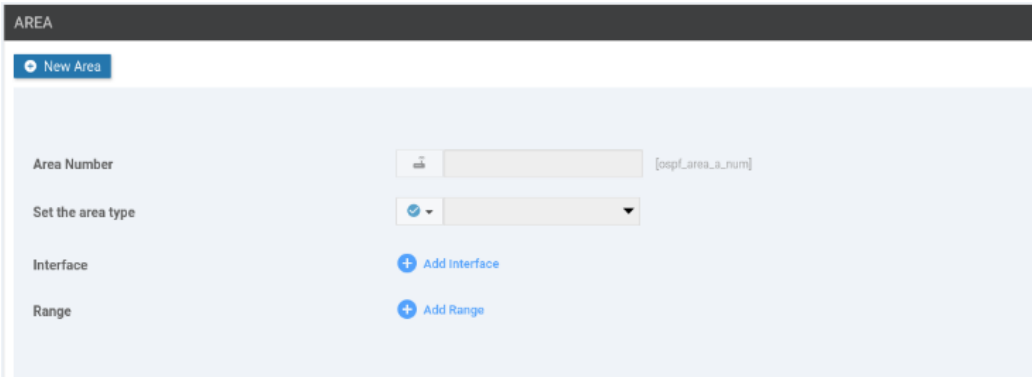
3. Specify the template name and description, then change the Router ID to device specific.



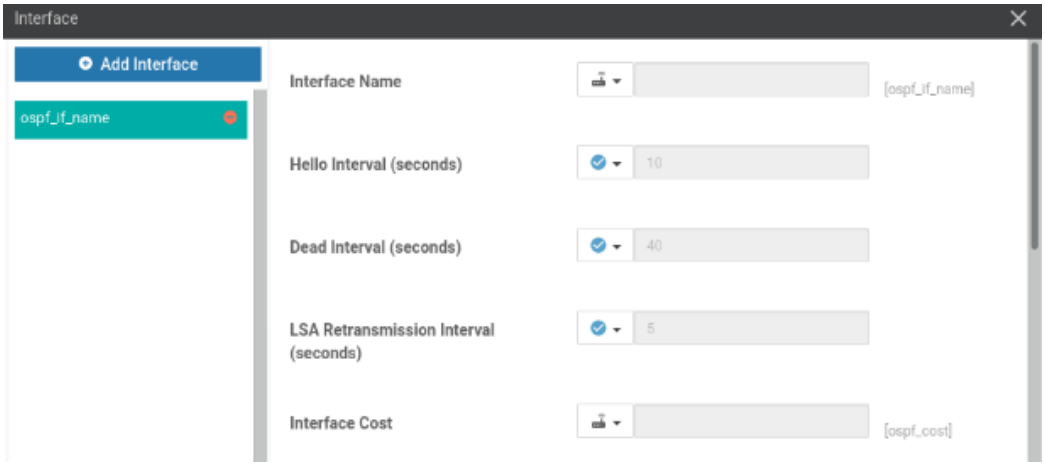
4. In the 'Redistribute' section, add redistribution for OMP, select device specific.



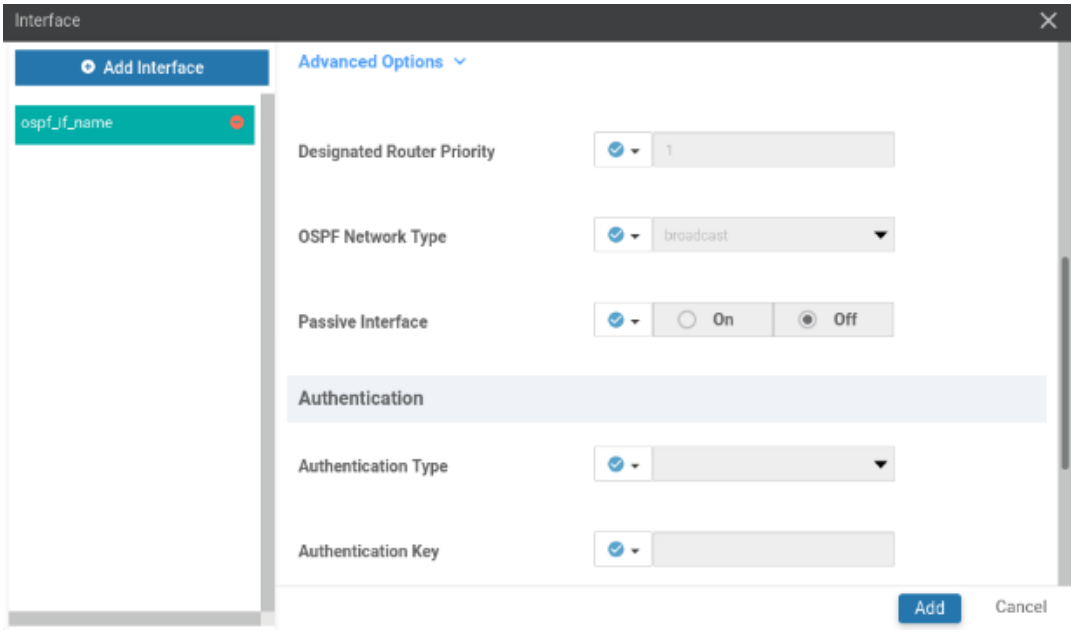
5. In the 'Area' section, add the area number as device specific, then click 'Add Interface'.



6. In the 'Interface' menu, configure the interface name and cost as device specific.

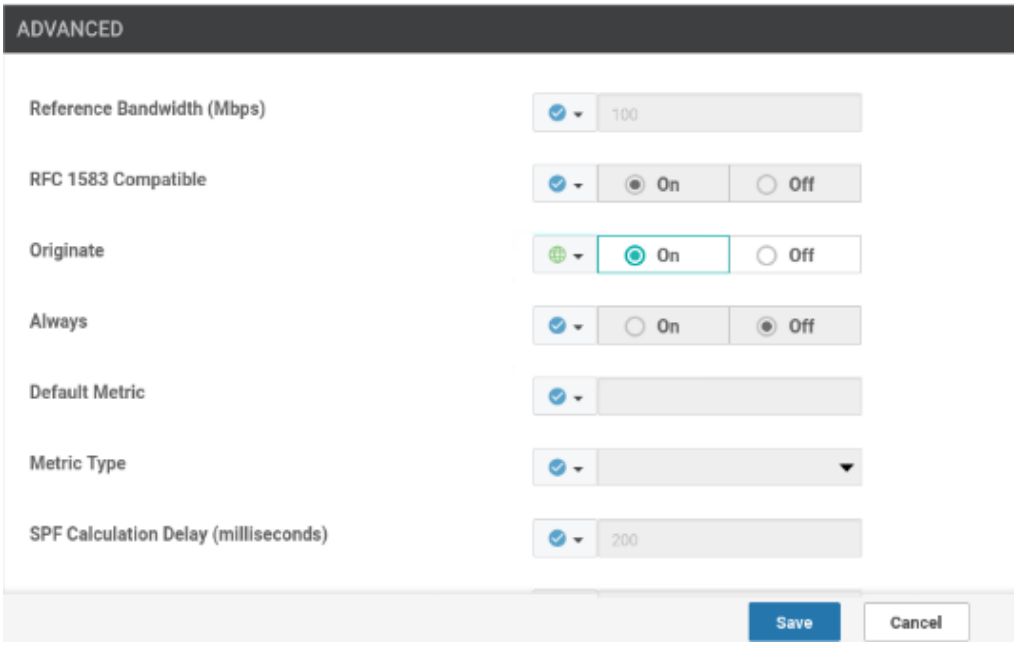


7. You can also configure network type and OSPF authentication by clicking on 'Advanced Options'.

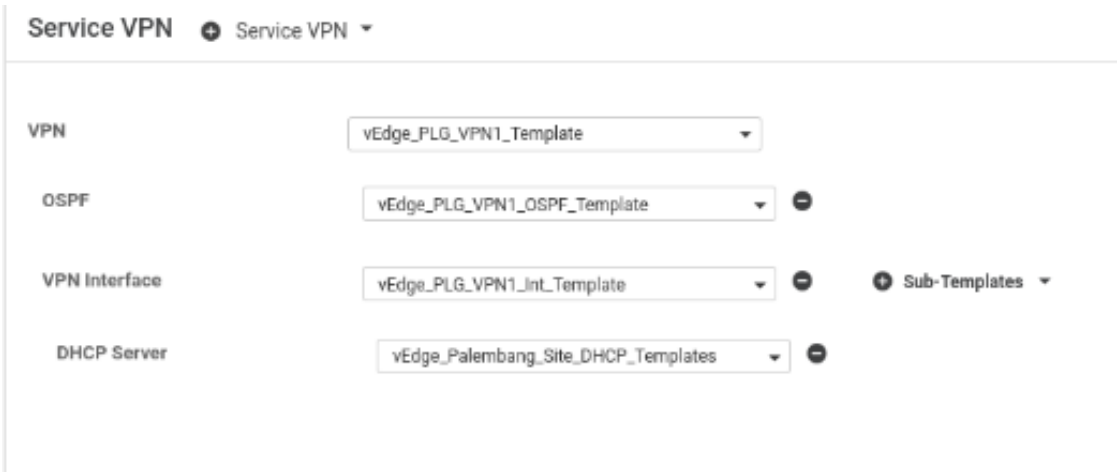


8. Once done, click 'Add' in the Interface menu, then 'Add' again in the Area section.

9. In the 'Advanced' section, enable 'Originate' for the default-information originate feature, then click 'Save'.



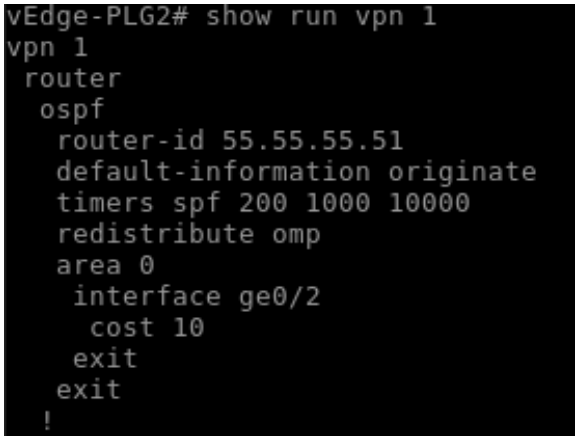
10. Add the OSPF feature template that has been created to VPN 1 in the Palembang Site device template, then click 'Update'.



11. Edit vEdge-PLG2 with the OSPF information to be applied, click 'Update' and 'Next'.

12. Verify the configuration before pushing it to vEdge-PLG2, and if everything is correct, click 'Configure Devices'.

13. The device template will successfully be pushed to vEdge-PLG2.



VPN 1 : OSPF Verfication

// show ospf neighbor

```
vEdge-PLG1# show ospf neighbor
DBsmL -> Database Summary List
RqstL -> Link State Request List
RXmtl -> Link State Retransmission List
       SOURCE
VPN    IP ADDRESS       INTERFACE        ROUTER ID        STATE
-------------------------------------------------------------------
0      50.1.1.2         ge0/1            2.2.2.4          full
1      172.16.51.2      ge0/2            55.55.55.51      full
1      172.16.51.171    ge0/2            50.50.50.100     full
```

```
vEdge-PLG2# show ospf neighbor
DBsmL -> Database Summary List
RqstL -> Link State Request List
RXmtl -> Link State Retransmission List
       SOURCE
VPN    IP ADDRESS       INTERFACE        ROUTER ID        STATE
-------------------------------------------------------------------
0      50.1.2.2         ge0/0            2.2.2.4          full
1      172.16.51.1      ge0/2            55.55.55.50      full
1      172.16.51.171    ge0/2            50.50.50.100     full
```

```
SITE-PALEMBANG#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
55.55.55.50       1   FULL/BDR        00:00:30    172.16.51.1     Ethernet0/0
55.55.55.51       1   FULL/DR         00:00:37    172.16.51.2     Ethernet0/0
```

// show ip route on SITE-PALEMBANG

What is special about SD-WAN is its ability to segment the network without concern for what happens in the Transport VPN. SITE-PALEMBANG receives routes from VPN 1.

```
SITE-PALEMBANG#show ip route ospf
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is 172.16.51.254 to network 0.0.0.0

      172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
O E2     172.16.21.0/24 [110/16777214] via 172.16.51.2, 00:11:42, Ethernet0/0
                        [110/16777214] via 172.16.51.1, 00:11:42, Ethernet0/0
O E2     172.16.31.0/24 [110/16777214] via 172.16.51.2, 00:05:05, Ethernet0/0
                        [110/16777214] via 172.16.51.1, 00:05:04, Ethernet0/0
O E2  192.168.21.0/24 [110/16777214] via 172.16.51.2, 00:11:42, Ethernet0/0
                      [110/16777214] via 172.16.51.1, 00:11:42, Ethernet0/0
O E2  192.168.22.0/24 [110/16777214] via 172.16.51.2, 00:11:42, Ethernet0/0
                      [110/16777214] via 172.16.51.1, 00:11:42, Ethernet0/0
O E2  192.168.23.0/24 [110/16777214] via 172.16.51.2, 00:11:42, Ethernet0/0
                      [110/16777214] via 172.16.51.1, 00:11:42, Ethernet0/0
O E2  192.168.31.0/24 [110/16777214] via 172.16.51.2, 00:05:05, Ethernet0/0
                      [110/16777214] via 172.16.51.1, 00:05:04, Ethernet0/0
O E2  192.168.32.0/24 [110/16777214] via 172.16.51.2, 00:05:05, Ethernet0/0
                      [110/16777214] via 172.16.51.1, 00:05:04, Ethernet0/0
O E2  192.168.33.0/24 [110/16777214] via 172.16.51.2, 00:05:05, Ethernet0/0
                      [110/16777214] via 172.16.51.1, 00:05:04, Ethernet0/0
```

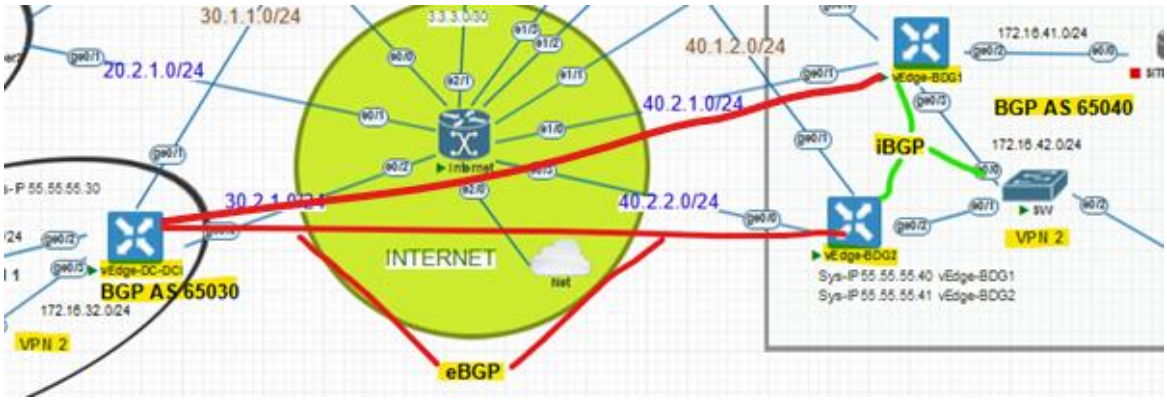
// ping segment vEdge-DC-DCI and vEdge-DRC-Cyber2 from SITE-PALEMBANG

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 41/54/62 ms
SITE-PALEMBANG#ping 192.168.21.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.21.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 38/54/71 ms
SITE-PALEMBANG#ping 192.168.22.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.22.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 42/51/61 ms
SITE-PALEMBANG#ping 192.168.23.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.23.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 55/59/64 ms
SITE-PALEMBANG#ping 192.168.31.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.31.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 51/63/72 ms
SITE-PALEMBANG#ping 192.168.32.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.32.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/64/72 ms
SITE-PALEMBANG#ping 192.168.33.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.33.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 55/62/72 ms
```

SERVICE VPN: BGP CONFIGURATION

Via CLI and Templates

Scenario:



In this scenario, for configuring BGP, we will use VPN 2. We will establish iBGP neighbor peering within the Bandung Site and eBGP neighbor peering between the Bandung Site and the DC-DCI Site.

vEdge-BDG1 will be configured through CLI, while vEdge-BDG2 and vEdge-DC-DCI will be configured using templates. For the vEdge-DC-DCI device, we will only need to add the BGP configuration and a few additional settings. Meanwhile, for vEdge-BDG2, a new Device Template will be created by incorporating the feature templates that have already been created, as described below.

- Basic Configuration > System
- VPN > VPN 0 (VPN (Default Route, OSPF), VPN Interface)
- VPN > VPN 512 (VPN, VPN Interface)
- VPN > VPN 1 (VPN, VPN Interface, OSPF) << we have not yet apply BGP routing
- Other Template > Banner

To provide a brief understanding, BGP has two types: Internal BGP (iBGP) and External BGP (eBGP). The difference between them lies in the scope of their connection. iBGP

operates within the same autonomous system (AS), while eBGP connects different autonomous systems. Other differences can be observed in the diagram below:

What's the deal with iBGP versus eBGP?
eBGP
iBGP
Between Autonomous Systems
Across an Autonomous System
Time to live – 1
Time to live – 255
Modifies AS path and Next Hop attributes
Does not modifies AS path and Next Hop attributes
Does not use Local Preference attribute
Does use Local Preference attribute
Administrative Distance – 20
Administrative Distance – 200
Advertises eBGP and iBGP learned routes to eBGP peer
Advertises eBGP learned routes to iBGP peer
Does not require full mesh of relationships
Does require full mesh of relationships

BGP is a type of routing protocol that uses path attributes to determine its routes, differing from OSPF and EIGRP, which rely on cost or metrics. In BGP, we can influence the paths taken by each prefix propagated or advertised by BGP routers. Therefore, in this BGP section, we will also configure the protocol to influence both inbound and outbound traffic paths used to reach or direct specific traffic.

Setup LAN Facing Device

// SITE-BANDUNG2

1. Configure the **SITE-BANDUNG2** device using **OSPF** for reachability within the Bandung Site and establish an **iBGP peering** with the vEdge device. Adjust the **Administrative Distance (AD)** so that it is higher than iBGP, ensuring that the iBGP protocol is selected as the best route. Advertise all **SITE-BANDUNG loopback prefixes** as follows:

```
interface Loopback0
 ip address 40.40.40.100 255.255.255.0
!
interface Loopback1
 ip address 192.168.46.10 255.255.255.0
```

```
 ip ospf network point-to-point
!
interface Loopback2
 ip address 192.168.47.10 255.255.255.0
 ip ospf network point-to-point
!
interface Loopback3
 ip address 192.168.48.10 255.255.255.0
 ip ospf network point-to-point
!
router ospf 1
 router-id 40.40.40.100
 network 0.0.0.0 255.255.255.255 area 0
 distance 210
!
router bgp 65040
 bgp router-id 40.40.40.100
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 40.40.40.1 remote-as 65040
 neighbor 40.40.40.1 update-source Loopback0
 neighbor 40.40.40.2 remote-as 65040
 neighbor 40.40.40.2 update-source Loopback0
 !
 address-family ipv4
  network 192.168.46.0 mask 255.255.255.0
  network 192.168.47.0 mask 255.255.255.0
  network 192.168.48.0 mask 255.255.255.0
  neighbor 40.40.40.1 activate
  neighbor 40.40.40.1 soft-reconfiguration inbound
```

```
 neighbor 40.40.40.2 activate
 neighbor 40.40.40.2 soft-reconfiguration inbound
exit-address-family
!
```

// DC2-DCI

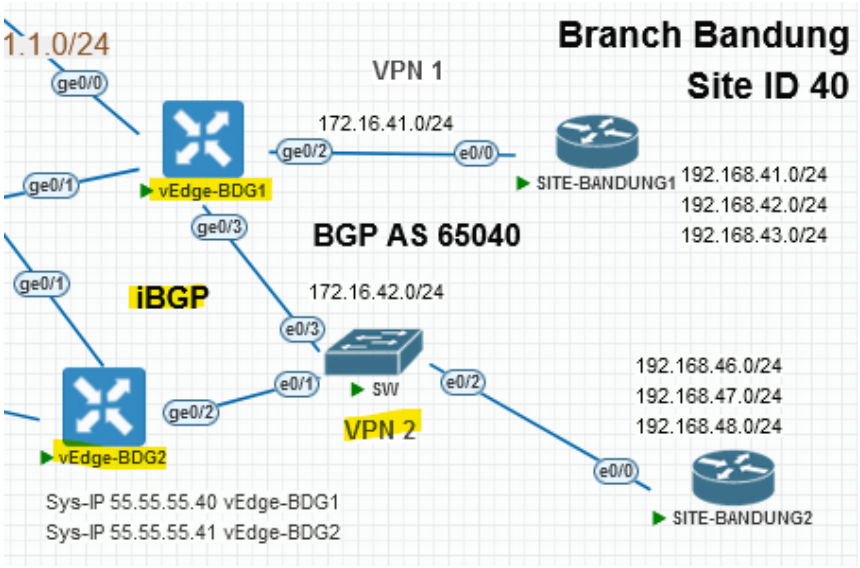
1. Configure the **DC2-DCI** device using **OSPF** for reachability within the DC2-DCI environment and establish an **iBGP peering** with the vEdge device. Adjust the **Administrative Distance (AD)** to prioritize iBGP over OSPF and advertise all **DC2-DCI loopback prefixes** as follows:

```
interface Loopback0
 ip address 30.30.30.100 255.255.255.0
!
interface Loopback1
 ip address 192.168.36.10 255.255.255.0
 ip ospf network point-to-point
!
interface Loopback2
 ip address 192.168.37.10 255.255.255.0
 ip ospf network point-to-point
!
interface Loopback3
 ip address 192.168.38.10 255.255.255.0
 ip ospf network point-to-point
!
router ospf 1
 router-id 30.30.30.100
 network 0.0.0.0 255.255.255.255 area 0
 distance 210
!
```

```
router bgp 65030
 bgp router-id 30.30.30.100
 bgp log-neighbor-changes
 no bgp default ipv4-unicast
 neighbor 30.30.30.1 remote-as 65030
 neighbor 30.30.30.1 update-source Loopback0
!
 address-family ipv4
  network 192.168.36.0 mask 255.255.255.0
  network 192.168.37.0 mask 255.255.255.0
  network 192.168.38.0 mask 255.255.255.0
  neighbor 30.30.30.1 activate
  neighbor 30.30.30.1 soft-reconfiguration inbound
 exit-address-family
!
```

VPN 2 : iBGP PEERING & ROUTE PROPAGATION

In this scenario, **vEdge-BDG1** and **vEdge-BDG2** are configured within the same autonomous system (AS) 65040. **OSPF** is utilized for reachability between each LAN-facing prefix in **SITE-BANDUNG**.



To achieve iBGP peering using **Loopback IP addresses**, OSPF is used for reachability. However, since the OSPF administrative distance (AD) is smaller (110) compared to iBGP (200), OSPF routes would typically be installed in the routing table. Therefore, OSPF's AD is increased to prioritize iBGP routes.

// via CLI

1. **[vEdge-BDG1]**
2. Configure Service VPN 2, use OSPF routing for reachability of each prefix and loopback addresses for peering and propagation processes, then increase the administrative distance.

```
vpn 2
 router
  ospf
   router-id 40.40.40.1
   default-information originate
   distance intra-area 210          << affect the selected route to become BGP.
```

```
 area 0
  interface ge0/3
   cost 5
  exit
  interface loopback0
  exit
 exit
!
bgp 65040
 router-id 40.40.40.1
 address-family ipv4-unicast
  redistribute omp                    << agar traffic yang dipelajari dari site lain di advertise ke BGP
 !
 neighbor 40.40.40.2
  description  To_vEdge-BDG2_iBGP
  no shutdown
  remote-as    65040
  update-source loopback0
  next-hop-self
 !
 neighbor 40.40.40.100
  no shutdown
  remote-as 65040
  update-source loopback0
  next-hop-self
 !
  interface ge0/3
ip address 172.16.42.1/24
no shutdown
vrrp 40
```

```
 priority 200
 track-omp
 ipv4 172.16.42.254
!
dhcp-server
 address-pool 172.16.42.0/24
 exclude     172.16.42.1 172.16.42.2 172.16.42.254
 options
  default-gateway 172.16.42.254
  dns-servers    8.8.8.8
 !
interface loopback0
 ip address 40.40.40.1/24
 no shutdown
```

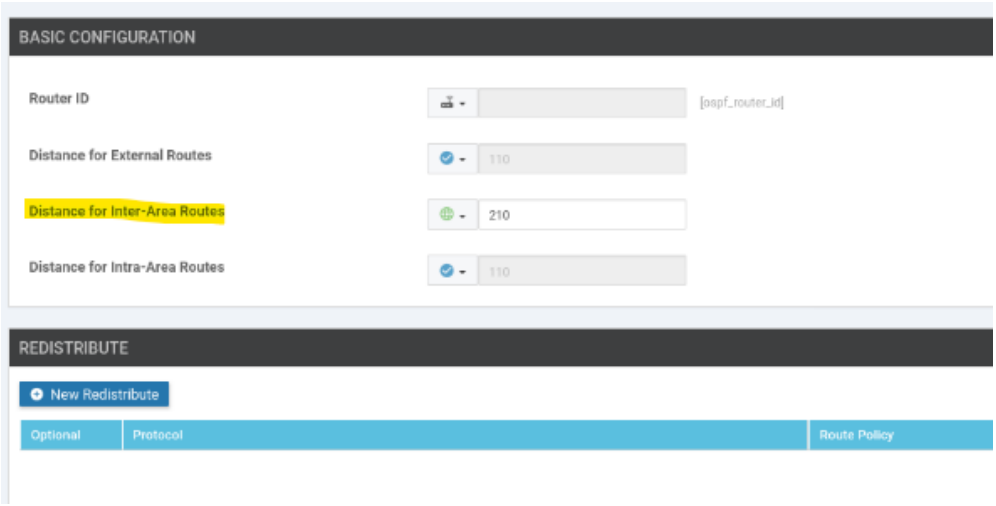
// via Templates

1. **[vEdge-BDG2]**

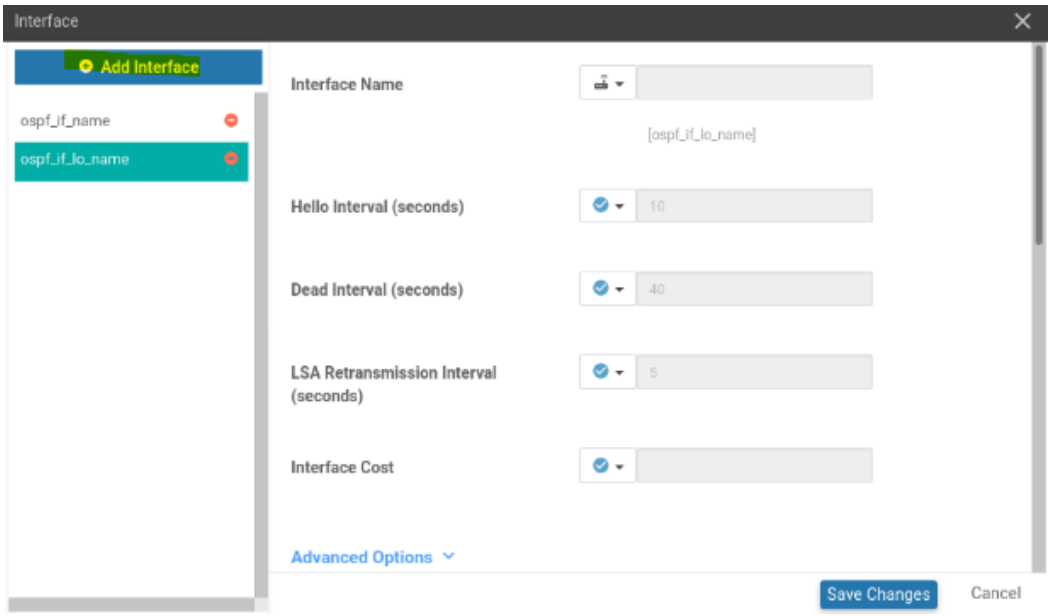
   Copy the feature template of VPN 0 and VPN 1 used by the device template for Palembang Site. **Don't forget to change the VPN template to 2**, use the VRRP feature, and apply a similar DHCP IP configuration for Bandung Site. Remove any configuration specific to the site that previously used the template to ensure the device template's prior configurations remain unaffected. Add a new template for the VPN 2 loopback interface.

vEdge_BDG_VPN0_Int_Ge0/0_Template	vEdge_BDG_VPN0_Int_Ge0...	WAN Edge Interface	vEdge Cloud
vEdge_BDG_VPN0_Int_Ge0/1_Template	vEdge_BDG_VPN0_Int_Ge0...	WAN Edge Interface	vEdge Cloud
vEdge_BDG_VPN0_OSPF_Template	vEdge_BDG_VPN0_OSPF_T...	OSPF	vEdge Cloud
vEdge_BDG_VPN0_Template	vEdge_BDG_VPN0_Template	WAN Edge VPN	vEdge Cloud
vEdge_BDG_VPN2_DHCP_Templates	vEdge_Palembang_Site_DH...	DHCP Server	vEdge Cloud
vEdge_BDG_VPN2_Int_Loopback_Template	vEdge_BDG_VPN2_Int_Loo...	WAN Edge Interface	vEdge Cloud
vEdge_BDG_VPN2_Int_Template	vEdge_BDG_VPN2_Int_Tem...	WAN Edge Interface	vEdge Cloud
vEdge_BDG_VPN2_OSPF_Template	vEdge_BDG_VPN2_OSPF_T...	OSPF	vEdge Cloud
vEdge_BDG_VPN2_Template	vEdge_BDG_VPN2_Template	WAN Edge VPN	vEdge Cloud

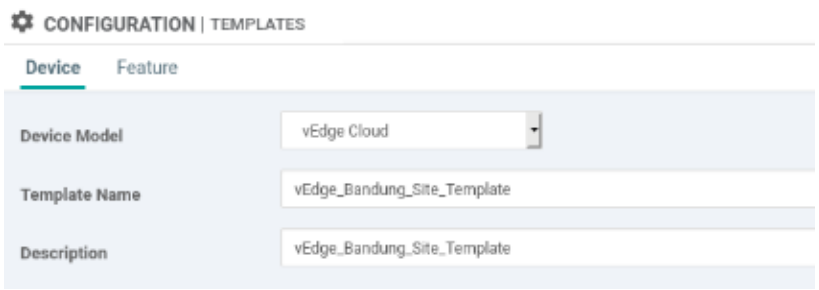
2. In the VPN 2 OSPF template, do not perform 'redistribute OMP' because the function of OSPF here is only for reachability at Bandung Site. Ensure all interconnections use BGP. Increase the administrative distance of OSPF to be greater than iBGP (200) and leave the redistribute option empty.



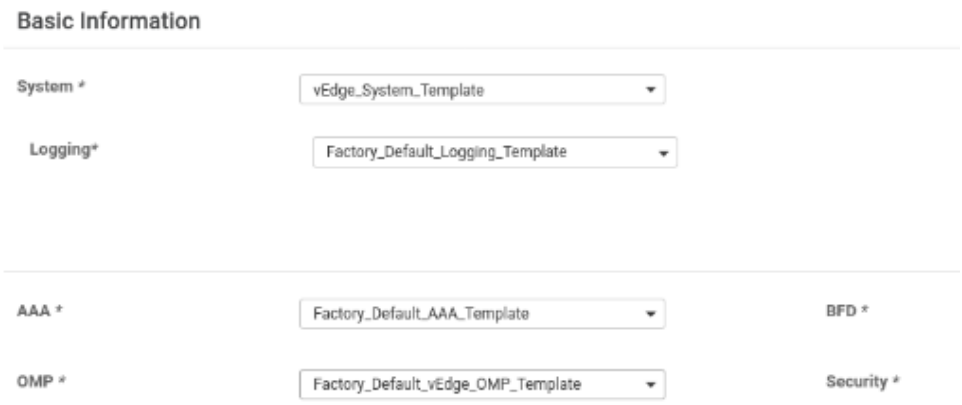
3. On the VPN 2 OSPF template, add the Loopback0 interface to be included in OSPF.



4. Buat device template baru untuk Bandung Site.



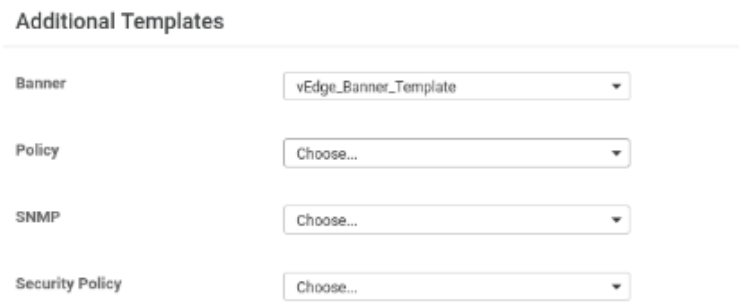
5. Basic Configuration



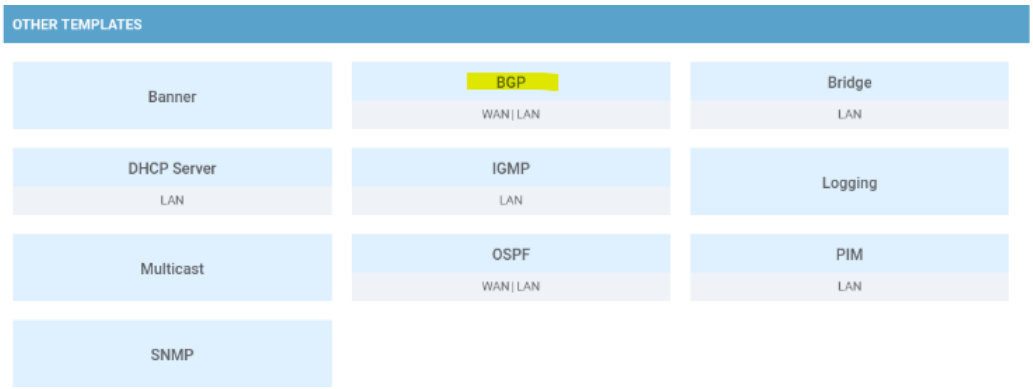
6. Transport & Management VPN

7. Service VPN

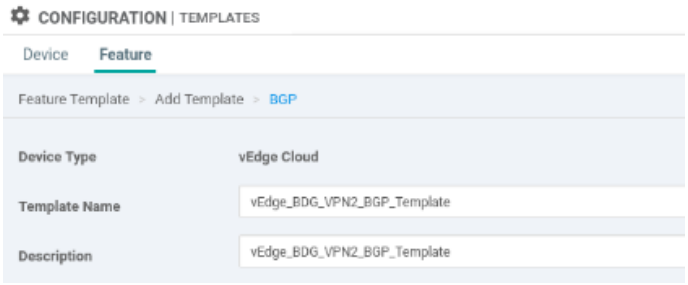
8. Addional Templates, then 'Create'



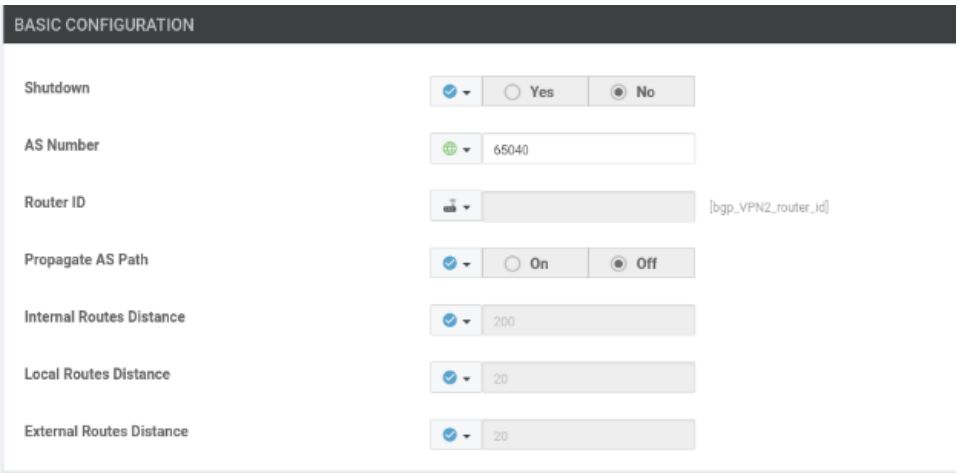
9. **Create and configure the BGP feature template** for VPN 2.



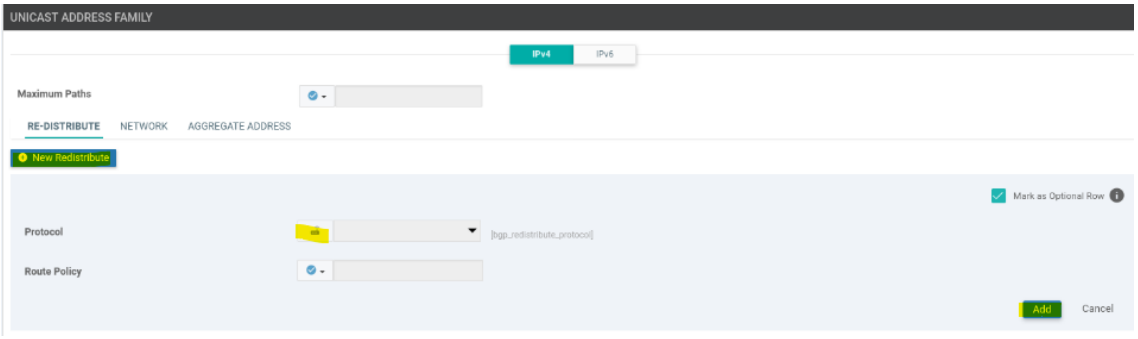
10. Name and describe the BGP feature template being created.



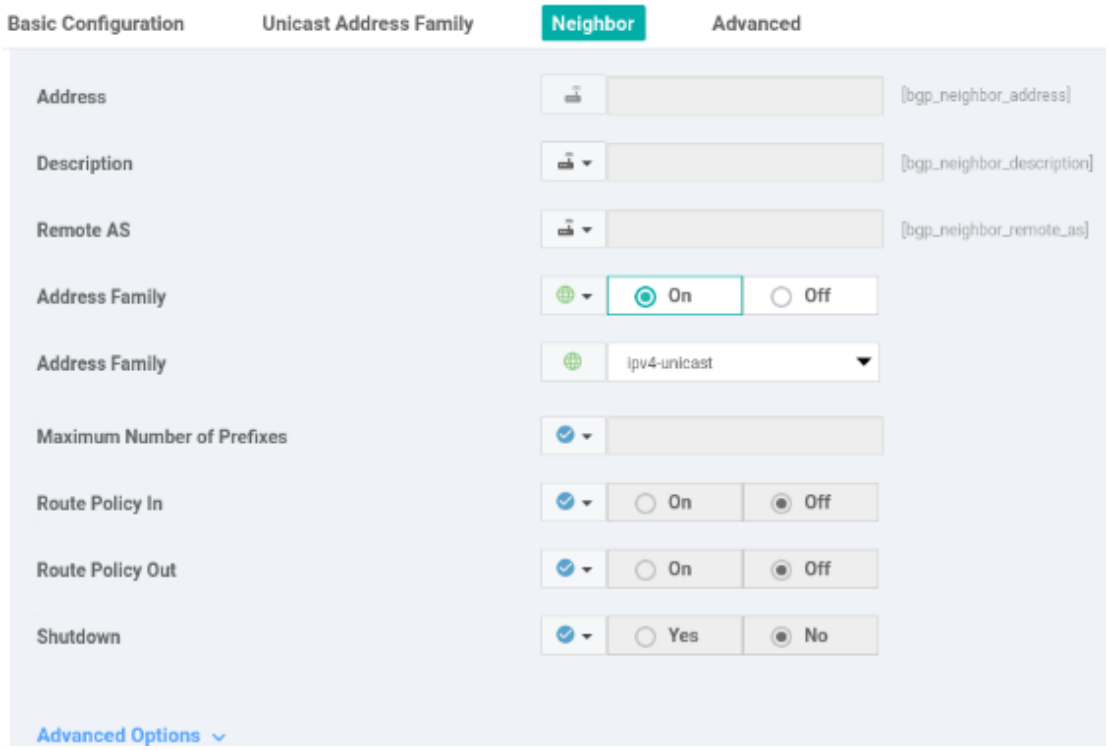
11. In the 'Basic Configuration' section, specify the BGP AS number for Bandung Site, using the Global option, then leave 'Router-id' with the device-specific option.



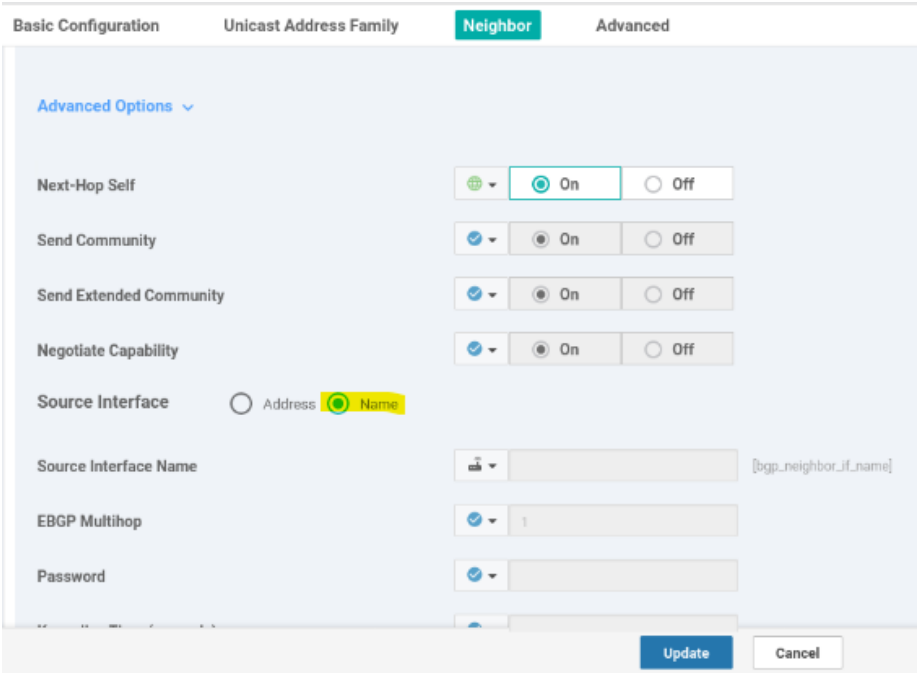
12. In the ‘Unicast Address Family’ section, select IPv4. Here, we can perform redistribution, advertise prefixes, and aggregate addresses. Redistribute OMP to allow prefixes learned at other sites to be advertised to BGP.



13. In the ‘Neighbor’ section, perform iBGP peering with vEdge-BDG1. Add a ‘New Neighbor’, then under Address, Description, and Remote-AS, choose the device-specific option, and activate the Address Family.

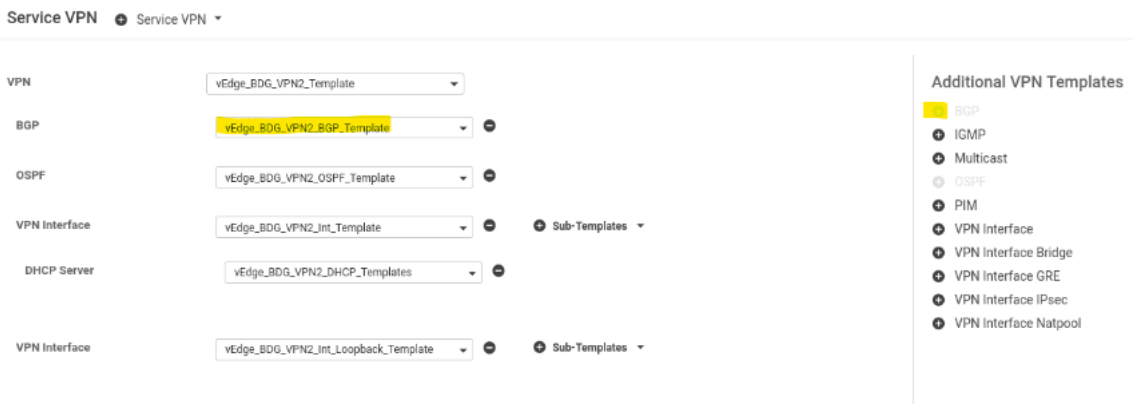


14. Still in the ‘Neighbor’ section, click ‘Advance Options’, activate Next-Hop Self, and use the device-specific option for the Source Interface Address for the peering process with the loopback address. Finally, ‘Add’ and ‘Save’ the feature template

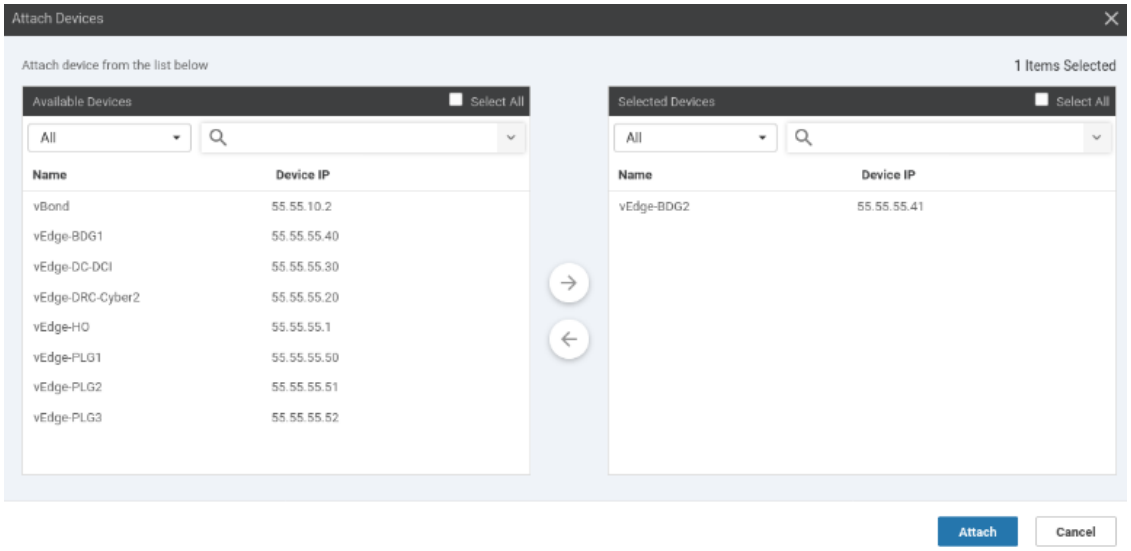


15. Add another ‘New Neighbor’ for BGP peering with SITE-BANDUNG2, following the same steps as above.

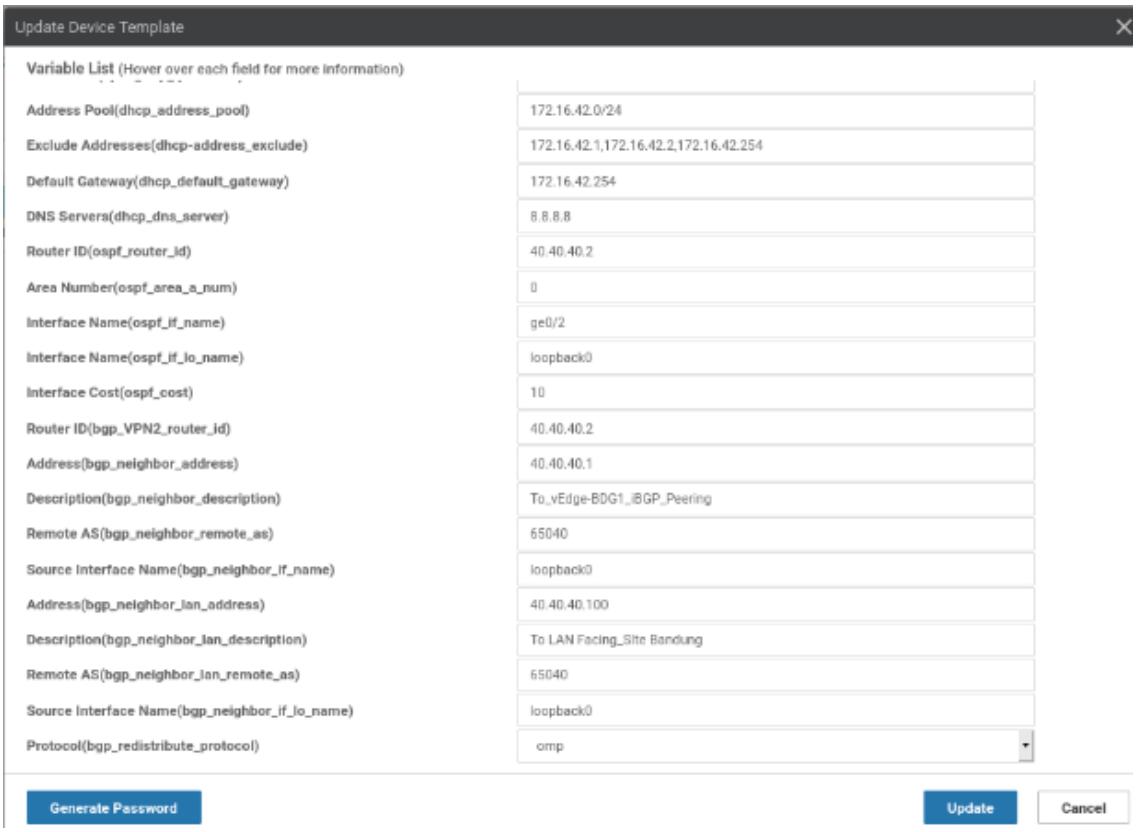
16. Add the created BGP feature template to the device template from Bandung Site, specifically under Service VPN 2, then ‘Update’.



17. Add vEdge-BDG2 to the Bandung Site device template that was created.



18. Edit all parameter values related to the device template according to the topology and scenario for vEdge-BDG2.



19. Verify Config Preview before pushing; if it's safe, click 'Configure Device'.

```
ospf
 router-id 40.40.40.2
 default-information originate
 timers spf 200 1000 10000
 area 0
  interface ge0/2
   cost 10
  exit
  interface loopback0
  exit
 exit
!
bgp 65040
 router-id 40.40.40.2
 neighbor 40.40.40.1
  description   To_vEdge-BDG1_iBGP_Peering
  no shutdown
  remote-as     65040
  update-source loopback0
  next-hop-self
  address-family ipv4-unicast
  !
 !
 neighbor 40.40.40.100
  description   "To LAN Facing_SIte Bandung"
  no shutdown
  remote-as     65040
  update-source loopback0
  next-hop-self
  address-family ipv4-unicast
  !
```

Back | Configure Devices | Cancel

20. Thus, the configuration is successfully pushed to vEdge-PLG2.

```
vEdge-BDG2# show run vpn 2
vpn 2
 router
  ospf
   router-id 40.40.40.2
   default-information originate
   timers spf 200 1000 10000
   area 0
    interface ge0/2
     cost 10
    exit
    interface loopback0
    exit
   exit
  !
  bgp 65040
   router-id 40.40.40.2
   address-family ipv4-unicast
    redistribute ospf
   !
   neighbor 40.40.40.1
    description   To_vEdge-BDG1_iBGP_Peering
    no shutdown
    remote-as     65040
    update-source loopback0
    next-hop-self
    address-family ipv4-unicast
    !
```

VPN 2 : iBGP Verification

For verification purposes, set up DRC-Cyber2 site so that BGP can advertise prefixes from OMP routes (prefixes from DRC-Cyber2) using redistribute OMP

// show ip route bgp (vEdge-BDG)

```
vEdge-BDG1# show ip route bgp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                          PROTOCOL  NEXTHOP     NEXTHOP
VPN     PREFIX              PROTOCOL      SUB TYPE  IF NAME     ADDR
-------------------------------------------------------------------------------
2       192.168.46.0/24     bgp           i         -           40.40.40.100
2       192.168.47.0/24     bgp           i         -           40.40.40.100
2       192.168.48.0/24     bgp           i         -           40.40.40.100
```

```
vEdge-BDG2# show ip route bgp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                          PROTOCOL  NEXTHOP     NEXTHOP
VPN     PREFIX              PROTOCOL      SUB TYPE  IF NAME     ADDR
-------------------------------------------------------------------------------
2       192.168.46.0/24     bgp           i         -           40.40.40.100
2       192.168.47.0/24     bgp           i         -           40.40.40.100
2       192.168.48.0/24     bgp           i         -           40.40.40.100
```

Has routes advertised on SITE-BANDUNG2

// show ip route (SITE-BANDUNG2)

```
SITE-BANDUNG2#show ip route bgp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is 172.16.42.254 to network 0.0.0.0

      20.0.0.0/32 is subnetted, 1 subnets
B        20.20.20.100 [200/1000] via 40.40.40.1, 00:28:42
      172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
B        172.16.22.0/24 [200/1000] via 40.40.40.1, 00:29:37
B     192.168.26.0/24 [200/1000] via 40.40.40.1, 00:28:42
B     192.168.27.0/24 [200/1000] via 40.40.40.1, 00:28:42
B     192.168.28.0/24 [200/1000] via 40.40.40.1, 00:28:42
```

Redistributed omp routes are accepted as BGP

// show bgp summary

```
vEdge-BDG1# show bgp summary
vpn                   2
bgp-router-identifier 40.40.40.1
local-as              65040
rib-entries           15
rib-memory            1680
total-peers           2
peer-memory           9632
Local-soo             SoO:0:40
ignore-soo
                      MSG       MSG       OUT                    PREFIX  PREFIX  PREFIX
NEIGHBOR         AS   RCVD      SENT      Q      UPTIME          RCVD    VALID   INSTALLED  STATE
-------------------------------------------------------------------------------------------------
40.40.40.2       65040 61        66        0      0:00:59:04      0       0       0          established
40.40.40.100     65040 68        65        0      0:00:58:58      3       3       3          established
```

```
vEdge-BDG2# show bgp sum
vpn                   2
bgp-router-identifier 40.40.40.2
local-as              65040
rib-entries           15
rib-memory            1680
total-peers           2
peer-memory           9632
Local-soo             SoO:0:40
ignore-soo
                      MSG       MSG       OUT                    PREFIX  PREFIX  PREFIX
NEIGHBOR         AS   RCVD      SENT      Q      UPTIME          RCVD    VALID   INSTALLED  STATE
-------------------------------------------------------------------------------------------------
40.40.40.1       65040 65        63        0      0:00:59:40      0       0       0          established
40.40.40.100     65040 69        63        0      0:00:59:39      3       3       3          established
```

```
SITE-BANDUNG2#show bgp sum
BGP router identifier 40.40.40.100, local AS number 65040
BGP table version is 11, main routing table version 11
8 network entries using 1152 bytes of memory
13 path entries using 1092 bytes of memory
2/2 BGP path/bestpath attribute entries using 320 bytes of memory
1 BGP extended community entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 2588 total bytes of memory
BGP activity 9/1 prefixes, 14/1 paths, scan interval 60 secs

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
40.40.40.1      4        65040      67      71       11    0    0 01:00:13        5
40.40.40.2      4        65040      64      70       11    0    0 01:00:18        5
```

There is 5 routes from SITE-BANDUNG2 perspective

// show received-routes (SITE-BANDUNG2)

```
SITE-BANDUNG2#show bgp ipv4 unicast neighbors 40.40.40.1 received-routes
BGP table version is 11, local router ID is 40.40.40.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i  20.20.20.100/32  40.40.40.1               1000     50      0 ?
 *>i  172.16.22.0/24   40.40.40.1               1000     50      0 ?
 *>i  192.168.26.0     40.40.40.1               1000     50      0 ?
 *>i  192.168.27.0     40.40.40.1               1000     50      0 ?
 *>i  192.168.28.0     40.40.40.1               1000     50      0 ?
```

All IPs on the DRC2-Cryber2 site are advertised because they are known as omp

// show ip bgp (SITE-BANDUNG2)

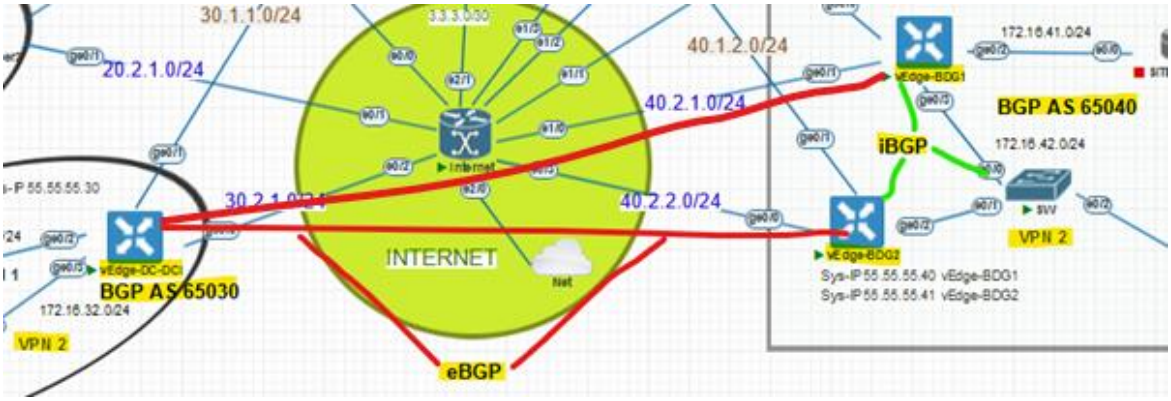
```
SITE-BANDUNG2#show ip bgp
BGP table version is 11, local router ID is 40.40.40.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 * i  20.20.20.100/32  40.40.40.2             1000     50      0 ?
 *>i                   40.40.40.1             1000     50      0 ?
 * i  172.16.22.0/24   40.40.40.2             1000     50      0 ?
 *>i                   40.40.40.1             1000     50      0 ?
 * i  192.168.26.0     40.40.40.2             1000     50      0 ?
 *>i                   40.40.40.1             1000     50      0 ?
 * i  192.168.27.0     40.40.40.2             1000     50      0 ?
 *>i                   40.40.40.1             1000     50      0 ?
 * i  192.168.28.0     40.40.40.2             1000     50      0 ?
 *>i                   40.40.40.1             1000     50      0 ?
 *>   192.168.46.0     0.0.0.0                   0         32768 i
 *>   192.168.47.0     0.0.0.0                   0         32768 i
 *>   192.168.48.0     0.0.0.0                   0         32768 i
```

// ping

```
SITE-BANDUNG2#ping 192.168.26.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.26.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 41/56/68 ms
SITE-BANDUNG2#ping 192.168.27.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.27.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 43/59/71 ms
SITE-BANDUNG2#ping 192.168.28.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.28.10, timeout is 2 seconds:
!!!!!
```

VPN 2 : eBGP PEERING & ROUTE PROPAGATION

In this eBGP scenario, we will establish peering and route propagation between autonomous systems (AS) from Bandung Site and DC-DCI Site. The devices vEdge-BDG2 and vEdge-DC-DCI are using the Template method, but for vEdge-BDG1, we will continue using the CLI. We only need to add a few parameters for vEdge-BDG1 and vEdge-BDG2 related to the neighbor peering to vEdge-DC-DCI, and then add the BGP setup from scratch for vEdge-DC-DCI.



If previously we used the prefix from DRC-Cyber2 as an example to obtain prefixes in the iBGP scenario, here **we will focus on prefixes that all originate from BGP (not from redistribute OMP).**

// **vEdge-BDG1**

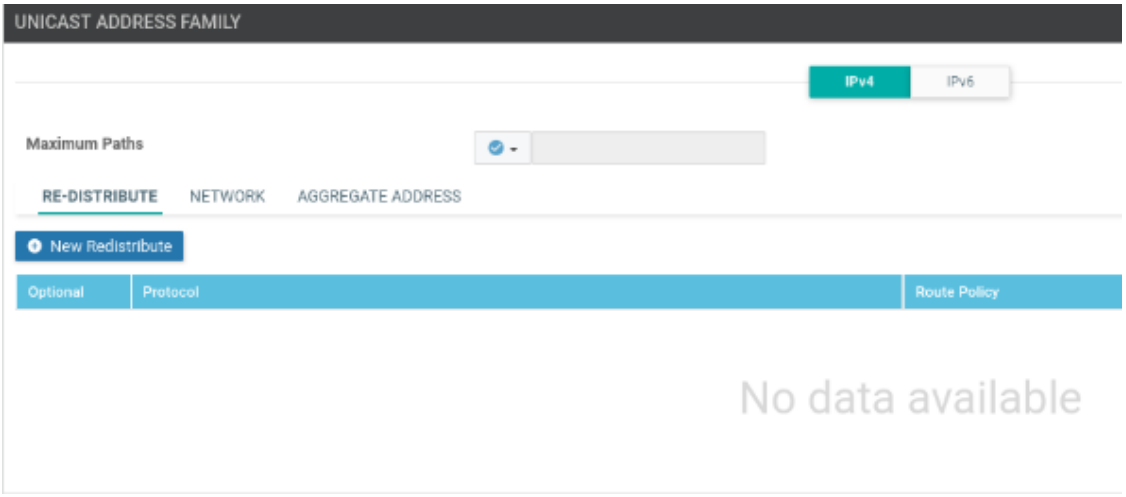
Add a neighbor to the vEdge-DC-DCI device, because we know that eBGP has a TTL of 1. Configure ebgp-multhop to increase the TTL for the eBGP peering process (since loopback is used, there will be 2 hops/TTL). Then, remove the configuration of 'redistribute omp'.

```
router bgp 65040
  address-family ipv4-unicast
   no redistribute omp
  !
  neighbor 30.30.30.1
   description  To_vEdge-DC-DCI_eBGP
```

```
no shutdown
remote-as    65030
update-source loopback0
ebgp-multihop 2
!
```

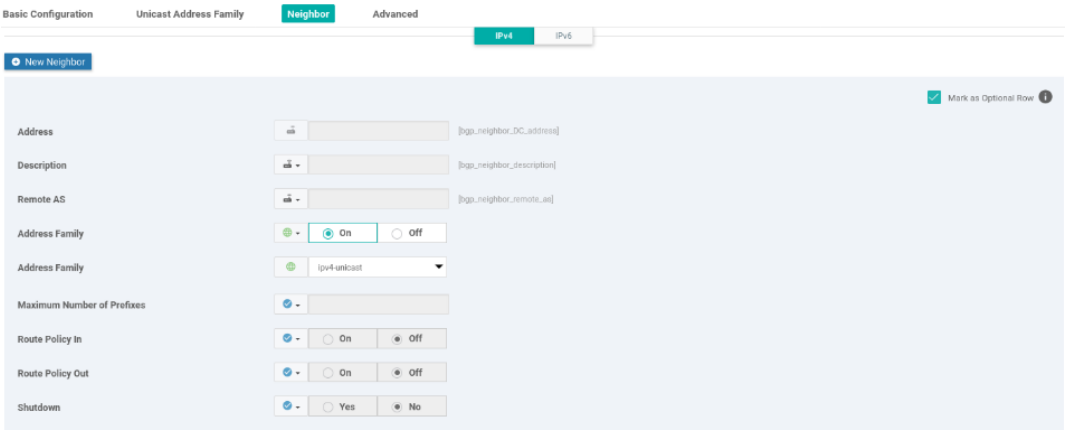
// **vEdge-BDG2**

1. In the BGP VPN2 feature template for Bandung Site, specifically in the 'Unicast Address Family' section, remove redistribute OMP.

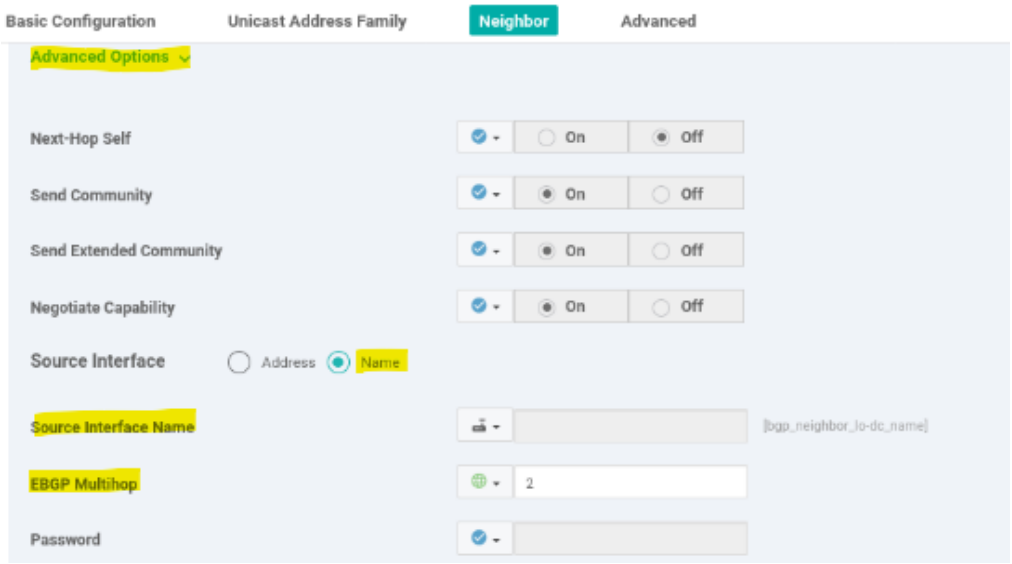


2. Next, we only need to add a neighbor to the loopback of vEdge-BDG2. Go to the BGP VPN 2 feature template for Bandung Site and select 'New Neighbor'.

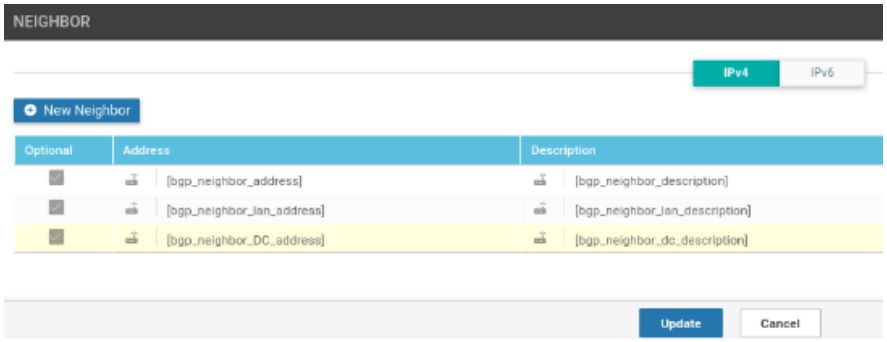
3. Set Address, Description, and Remote-AS to device-specific options, then activate Address-family.



4. Still in the 'Neighbor' section, expand 'Advanced Options', then change the Source Interface to 'Name' to update the source interface. Since this is eBGP, assign a value to EBGP Multihop to increase the TTL for the peering process. Once done, click 'Add' and then 'Update'.



5. vEdge-BDG2 will now have 3 neighbors; proceed to 'Update'.



6. Edit the Device Template to add the updated parameter values for the vEdge-BDG2 device. Once complete, click ‘Update’ and then ‘Next’.

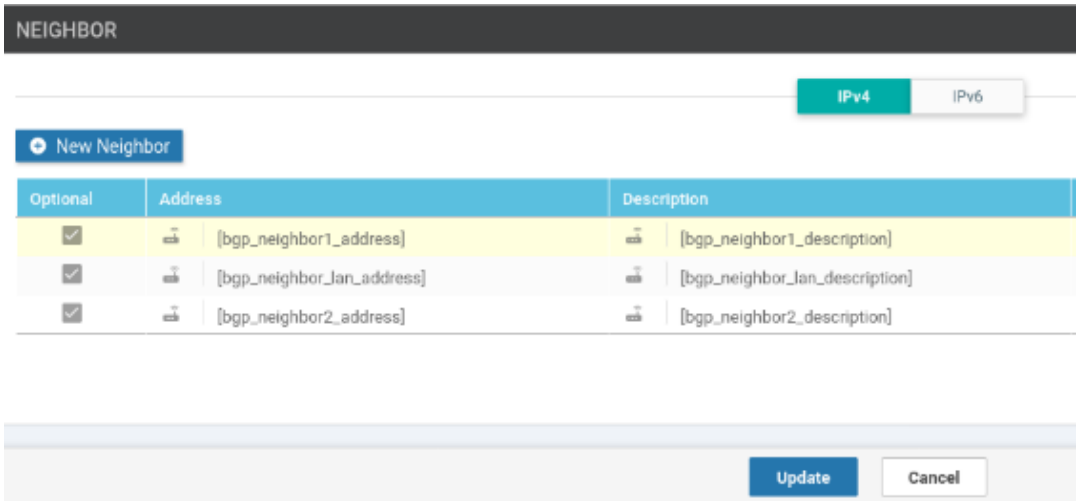
7. Verify the configuration before pushing it to vEdge-BDG2. If everything is safe, proceed to ‘Configure Devices’.
8. The configuration has been successfully pushed to vEdge-BDG2.

```
neighbor 30.30.30.1
 description   To_vEdge-DC-DCI_eBGP
 no shutdown
 remote-as     65030
 update-source loopback0
 ebgp-multihop 2
 address-family ipv4-unicast
 !
```

// vEdge-DC-DCI

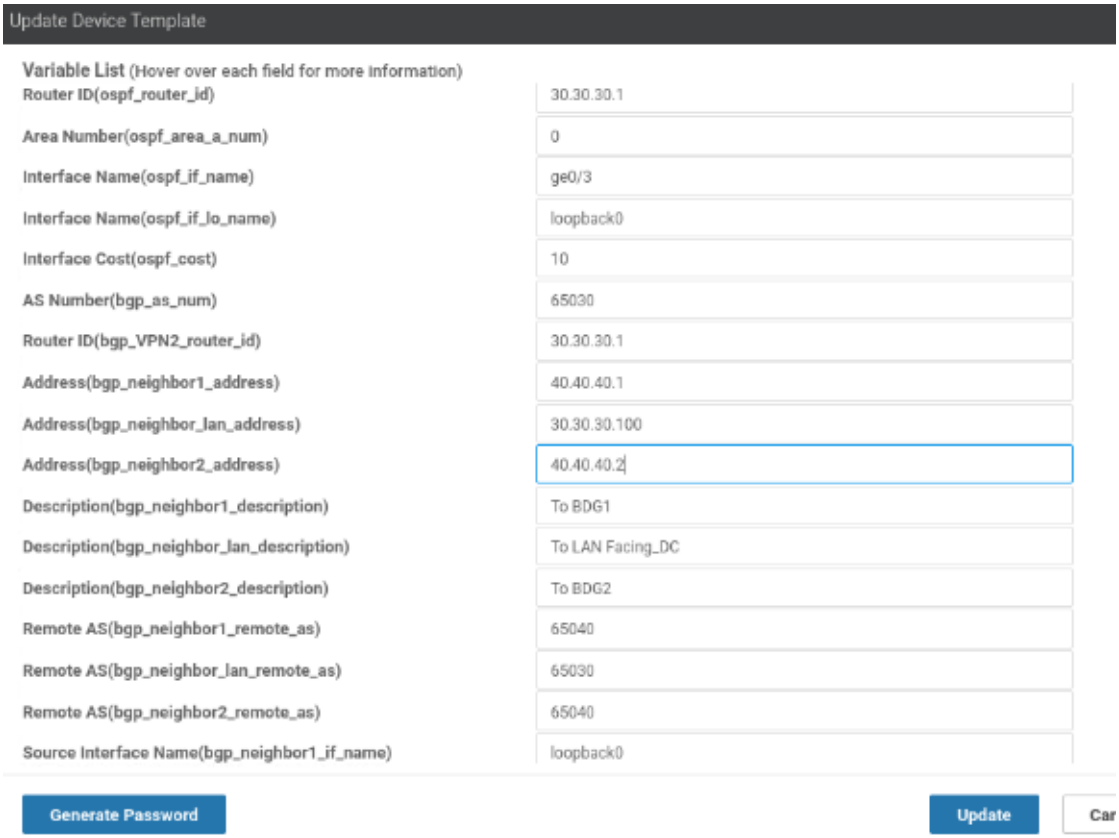
1. Copy all related feature templates for VPN 2 from the previous vEdge-BDG2. Remove any configurations specific to vEdge-BDG2. On vEdge-DC-DCI, there is only one path from the LAN perspective, so don’t forget to remove the VRRP configuration.

2. Focus on the BGP feature template. There are 3 neighbors on this site, same as before. However, the neighbor leading to Bandung Site does not use Next-hop self. We need to add EBGP Multihop for the neighbor leading to that site. Once done, click 'Update'.

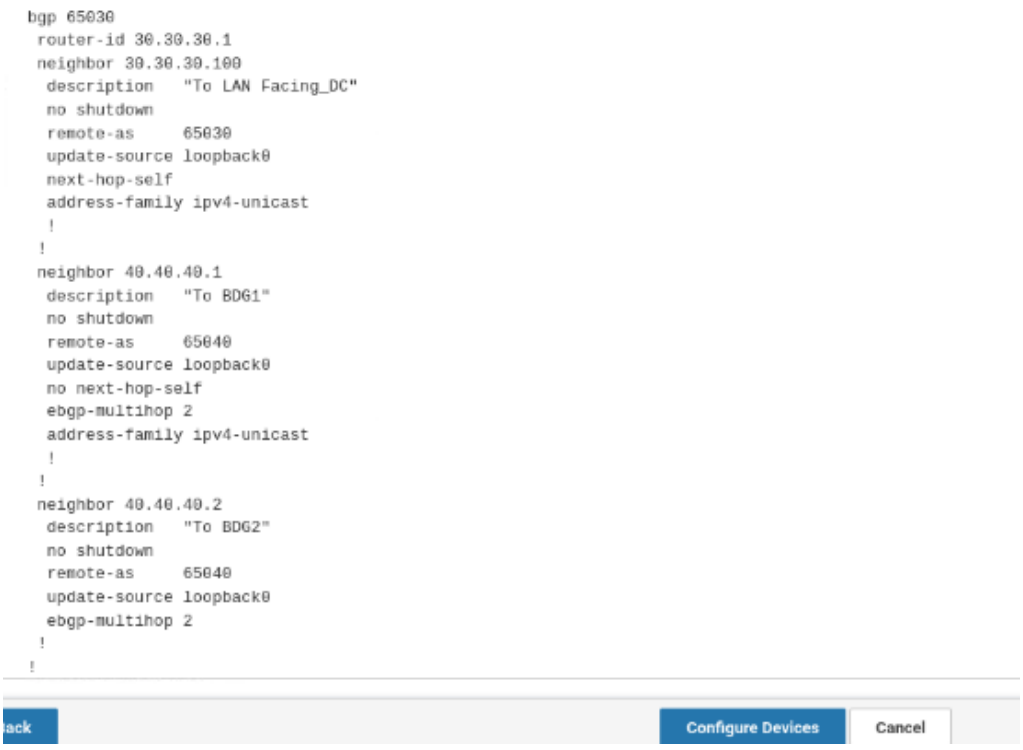


3. Since the device template for DC-DCI already exists, we only need to include all relevant feature templates for VPN 2, including OSPF and BGP. Once complete, click 'Update'.

4. Fill in all required parameter values for the newly added feature template for VPN 2.



5. Verify the configuration before pushing it to the vEdge-DC-DCI device. If everything is safe, click 'Configure Devices'.



6. Thus, the template configuration has been successfully pushed to the device.

```
vEdge-DC-DCI# show run vpn 2
vpn 2
 router
  ospf
   router-id 30.30.30.1
   default-information originate
   timers spf 200 1000 10000
   area 0
    interface ge0/3
     cost 10
    exit
    interface loopback0
    exit
   exit
  !
  bgp 65030
   router-id 30.30.30.1
   neighbor 30.30.30.100
    description   "To LAN Facing_DC"
    no shutdown
    remote-as     65030
    update-source loopback0
    next-hop-self
    address-family ipv4-unicast
    !
```

VPN 2 : eBGP Verification

// show ip route bgp (vEdge-BDG & vEdge-DC-DCI)

```
vEdge-BDG1# show ip route bgp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                          PROTOCOL  NEXTHOP     NEXTHOP
VPN    PREFIX              PROTOCOL       SUB TYPE  IF NAME     ADDR
-------------------------------------------------------------------------------
2      192.168.36.0/24     bgp            i         -           30.30.30.1
2      192.168.37.0/24     bgp            i         -           30.30.30.1
2      192.168.38.0/24     bgp            i         -           30.30.30.1
2      192.168.46.0/24     bgp            i         -           40.40.40.100
2      192.168.47.0/24     bgp            i         -           40.40.40.100
2      192.168.48.0/24     bgp            i         -           40.40.40.100
```

```
vEdge-BDG2# show ip route bgp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                          PROTOCOL  NEXTHOP     NEXTHOP
VPN    PREFIX              PROTOCOL       SUB TYPE  IF NAME     ADDR
-------------------------------------------------------------------------------
2      192.168.36.0/24     bgp            i         -           30.30.30.1
2      192.168.37.0/24     bgp            i         -           30.30.30.1
2      192.168.38.0/24     bgp            i         -           30.30.30.1
2      192.168.46.0/24     bgp            i         -           40.40.40.100
2      192.168.47.0/24     bgp            i         -           40.40.40.100
2      192.168.48.0/24     bgp            i         -           40.40.40.100
```

```
vEdge-DC-DCI# show ip route bgp
Codes Proto-sub-type:
  IA -> ospf-intra-area, IE -> ospf-inter-area,
  E1 -> ospf-external1, E2 -> ospf-external2,
  N1 -> ospf-nssa-external1, N2 -> ospf-nssa-external2,
  e -> bgp-external, i -> bgp-internal
Codes Status flags:
  F -> fib, S -> selected, I -> inactive,
  B -> blackhole, R -> recursive

                                          PROTOCOL  NEXTHOP     NEXTHOP
VPN    PREFIX              PROTOCOL       SUB TYPE  IF NAME     ADDR
-------------------------------------------------------------------------------
2      192.168.36.0/24     bgp            i         -           30.30.30.100
2      192.168.37.0/24     bgp            i         -           30.30.30.100
2      192.168.38.0/24     bgp            i         -           30.30.30.100
2      192.168.46.0/24     bgp            i         -           40.40.40.2
2      192.168.47.0/24     bgp            i         -           40.40.40.2
2      192.168.48.0/24     bgp            i         -           40.40.40.2
```

Have mutual routes advertised from the Lan Facing perspective

// show ip route (SITE-BANDUNG2 & DC2-DCI)

```
DC2-DCI#show ip route bgp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is 172.16.32.1 to network 0.0.0.0

B     192.168.46.0/24 [200/0] via 30.30.30.1, 00:57:15
B     192.168.47.0/24 [200/0] via 30.30.30.1, 00:57:15
B     192.168.48.0/24 [200/0] via 30.30.30.1, 00:57:15
```

```
SITE-BANDUNG2#show ip route bgp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is 172.16.42.254 to network 0.0.0.0

B     192.168.36.0/24 [200/0] via 40.40.40.1, 00:57:35
B     192.168.37.0/24 [200/0] via 40.40.40.1, 00:57:35
B     192.168.38.0/24 [200/0] via 40.40.40.1, 00:57:35
```

Prefixes from each other are installed into the routing table as BGP

// show bgp summary

```
vEdge-BDG1# show bgp summary
vpn                   2
bgp-router-identifier  40.40.40.1
local-as              65040
rib-entries           11
rib-memory            1232
total-peers           3
peer-memory           14448
Local-soo             SoO:0:40
ignore-soo
                      MSG       MSG       OUT                    PREFIX  PREFIX  PREFIX
NEIGHBOR         AS   RCVD      SENT      Q      UPTIME          RCVD    VALID   INSTALLED  STATE
-----------------------------------------------------------------------------------------------
30.30.30.1       65030 123       121       0      0:01:53:11      3       3       3          established
40.40.40.2       65040 399       400       0      0:06:30:24      3       3       0          established
40.40.40.100     65040 429       402       0      0:01:28:11      3       3       3          established
```

```
vEdge-BDG2# show bgp summary
vpn                   2
bgp-router-identifier  40.40.40.2
local-as              65040
rib-entries           11
rib-memory            1232
total-peers           3
peer-memory           14448
Local-soo             SoO:0:40
ignore-soo
                      MSG       MSG       OUT                    PREFIX  PREFIX  PREFIX
NEIGHBOR         AS   RCVD      SENT      Q      UPTIME          RCVD    VALID   INSTALLED  STATE
-----------------------------------------------------------------------------------------------
30.30.30.1       65030 120       122       0      0:01:54:05      3       3       3          established
40.40.40.1       65040 399       401       0      0:06:31:04      3       3       0          established
40.40.40.100     65040 430       402       0      0:01:28:50      3       3       3          established
```

```
vEdge-DC-DCI# show bgp sum
vpn                   2
bgp-router-identifier  30.30.30.1
local-as              65030
rib-entries           11
rib-memory            1232
total-peers           3
peer-memory           14448
Local-soo             SoO:0:30
ignore-soo
                      MSG       MSG       OUT                    PREFIX  PREFIX  PREFIX
NEIGHBOR         AS   RCVD      SENT      Q      UPTIME          RCVD    VALID   INSTALLED  STATE
-----------------------------------------------------------------------------------------------
30.30.30.100     65030 110       103       0      0:01:31:52      3       3       3          established
40.40.40.1       65040 120       125       0      0:01:54:25      3       3       0          established
40.40.40.2       65040 121       122       0      0:01:54:40      3       3       3          established
```

```
SITE-BANDUNG2#show ip bgp sum
BGP router identifier 40.40.40.100, local AS number 65040
BGP table version is 16, main routing table version 16
6 network entries using 864 bytes of memory
9 path entries using 756 bytes of memory
2/2 BGP path/bestpath attribute entries using 320 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1964 total bytes of memory
BGP activity 6/0 prefixes, 15/6 paths, scan interval 60 secs

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
40.40.40.1      4        65040      95     103       16    0    0 01:29:59        3
40.40.40.2      4        65040      95     103       16    0    0 01:29:58        3
```

```
DC2-DCI#show ip bgp sum
BGP router identifier 30.30.30.100, local AS number 65030
BGP table version is 16, main routing table version 16
6 network entries using 864 bytes of memory
6 path entries using 504 bytes of memory
2/2 BGP path/bestpath attribute entries using 328 bytes of memory
1 BGP AS-PATH entries using 24 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 1720 total bytes of memory
BGP activity 6/0 prefixes, 6/0 paths, scan interval 60 secs

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
30.30.30.1      4        65030      96     106       16    0    0 01:32:58        3
```

// show received-routes (SITE-BANDUNG2 & DC2-DCI)

```
SITE-BANDUNG2#show bgp ipv4 unicast neighbors 40.40.40.1 received-routes
BGP table version is 16, local router ID is 40.40.40.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i  192.168.36.0     40.40.40.1                100      0 65030 i
 *>i  192.168.37.0     40.40.40.1                100      0 65030 i
 *>i  192.168.38.0     40.40.40.1                100      0 65030 i

Total number of prefixes 3
```

```
DC2-DCI#show bgp ipv4 unicast neighbors 30.30.30.1 received-routes
BGP table version is 16, local router ID is 30.30.30.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>i  192.168.46.0     30.30.30.1                100      0 65040 i
 *>i  192.168.47.0     30.30.30.1                100      0 65040 i
 *>i  192.168.48.0     30.30.30.1                100      0 65040 i

Total number of prefixes 3
```

// show ip bgp (SITE-BANDUNG2 & DC2-DCI)

```
DC2-DCI#show ip bgp
BGP table version is 16, local router ID is 30.30.30.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - in
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-F
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>   192.168.36.0     0.0.0.0                  0         32768 i
 *>   192.168.37.0     0.0.0.0                  0         32768 i
 *>   192.168.38.0     0.0.0.0                  0         32768 i
 *>i  192.168.46.0     30.30.30.1                    100      0 65040 i
 *>i  192.168.47.0     30.30.30.1                    100      0 65040 i
 *>i  192.168.48.0     30.30.30.1                    100      0 65040 i
```

```
SITE-BANDUNG2#show ip bgp
BGP table version is 16, local router ID is 40.40.40.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 * i  192.168.36.0     40.40.40.2               100      0 65030 i
 *>i                   40.40.40.1               100      0 65030 i
 * i  192.168.37.0     40.40.40.2               100      0 65030 i
 *>i                   40.40.40.1               100      0 65030 i
 * i  192.168.38.0     40.40.40.2               100      0 65030 i
 *>i                   40.40.40.1               100      0 65030 i
 *>   192.168.46.0     0.0.0.0                  0         32768 i
 *>   192.168.47.0     0.0.0.0                  0         32768 i
 *>   192.168.48.0     0.0.0.0                  0         32768 i
```

// ping

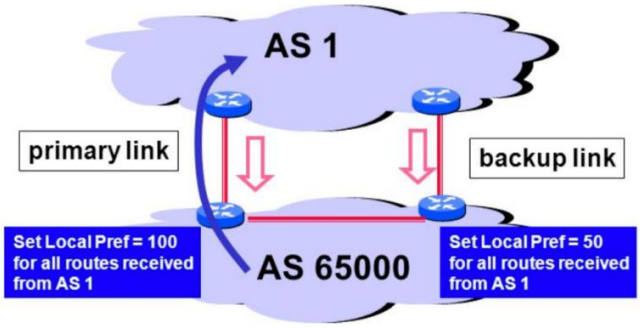
```
DC2-DCI#ping 192.168.46.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.46.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/66/82 ms
DC2-DCI#ping 192.168.47.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.47.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 41/53/62 ms
DC2-DCI#ping 192.168.48.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.48.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 58/66/72 ms
```

```
SITE-BANDUNG2#ping 192.168.36.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.36.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 50/65/72 ms
SITE-BANDUNG2#ping 192.168.37.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.37.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 51/66/72 ms
SITE-BANDUNG2#ping 192.168.38.10
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.38.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 40/51/62 ms
```

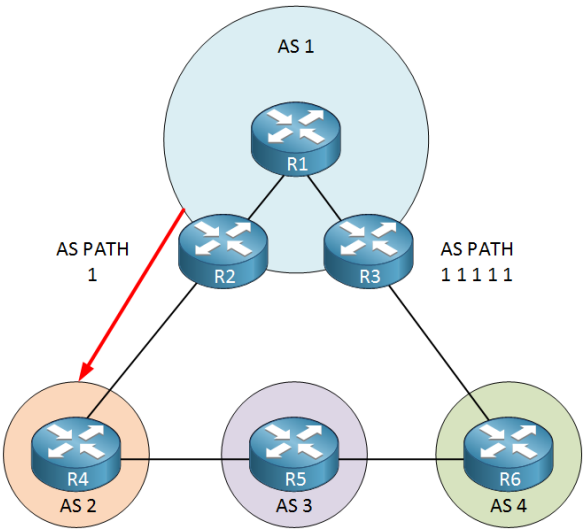
VPN 2 : BGP Localized Route Policy

BGP is a protocol that uses path attributes that can be applied to each prefix connected in BGP. Path attributes can be used as a method to influence the route taken by a prefix to its destination. In this scenario, we will apply route policies using the following path attributes:

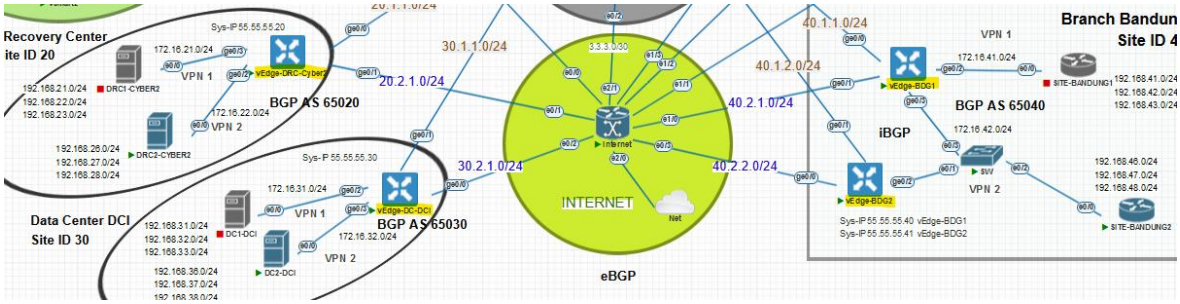
a. **Local Preference (Outbound)**, From the perspective of our intranet, if a prefix enters the intranet, it will be set with a local preference by the BGP router. When the intranet wants to reach that prefix, in cases where there are two path options or BGP routers, **the intranet will choose the path with the highest local preference as the best route.**



b. **AS Path (Inbound),** for this attribute, the opposite is true. It is viewed from the perspective of the extranet. Our BGP routers (intranet) influence the paths they take by providing information regarding the AS-PATHs they should follow to reach the destination address within the intranet. **The more AS-PATHs that need to be traversed, the less likely the path will be chosen.**



// SKENARIO



In this scenario, **all configurations** are **performed only on vEdge-BDG1 & vEdge-BDG2**. SITE-BANDUNG already has prefixes from the vEdge-DC-DCI devices. In this scenario, we **also need prefixes from vEdge-DRC-Cyber2**. Therefore, on the vEdge-BDG devices, establish neighbor peering with vEdge-DRC-Cyber2 and advertise the prefixes from DRC-Cyber2. The following are the prefixes owned by SITE-BANDUNG2 after prefixes from the DRC Cyber2 site are redistributed into BGP for the route policy scenario we are implementing:

```
SITE-BANDUNG2#show ip bgp
BGP table version is 61, local router ID is 40.40.40.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 * i  192.168.26.0     40.40.40.2               11    100      0 65020 i
 *>i                   40.40.40.1               11    100      0 65020 i
 * i  192.168.27.0     40.40.40.2               11    100      0 65020 i
 *>i                   40.40.40.1               11    100      0 65020 i
 * i  192.168.28.0     40.40.40.2               11    100      0 65020 i
 *>i                   40.40.40.1               11    100      0 65020 i
 *>i  192.168.36.0     40.40.40.1                     100      0 65030 i
 * i                   40.40.40.2                     100      0 65030 i
 *>i  192.168.37.0     40.40.40.1                     100      0 65030 i
 * i                   40.40.40.2                     100      0 65030 i
 *>i  192.168.38.0     40.40.40.1                     100      0 65030 i
 * i                   40.40.40.2                     100      0 65030 i
```

The points to be implemented and the configurations related to this BGP route policy include:

-- vEdge-BDG1 via CLI --

- **[Local Pref]** Prefix **outbond to** DRC Cyber2 Site (**192.168.2x.0**) will go through via **40.40.40.1**, with **local preference greater than default**
- **[AS Path]** Prefix **inbound to** Bandung Site from DRC Cyber2 Site, it is made **symmetric via 40.40.40.1 (vEdge-BDG1)** by **manipulating the AS-path prepend** sent by vEdge-BDG2 (so that the prefixes from DRC Cyber2 prefer vEdge-BDG1).

-- vEdge-BDG2 via Template --

- **[Local Pref]** Prefix **outbond to** DC-DCI Site (**192.168.3x.0**) will go through via **40.40.40.2**, with **local preference greater than default**
- **[AS Path]** Prefix **inbound to** Bandung Site from DC-DCI Site, it is made **symmetric via 40.40.40.2 (vEdge-BDG2)** by **manipulating the AS-path prepend** sent by vEdge-BDG1 (so that the prefixes from DC-DCI prefer vEdge-BDG2).

// vEdge-BDG1 (via CLI)

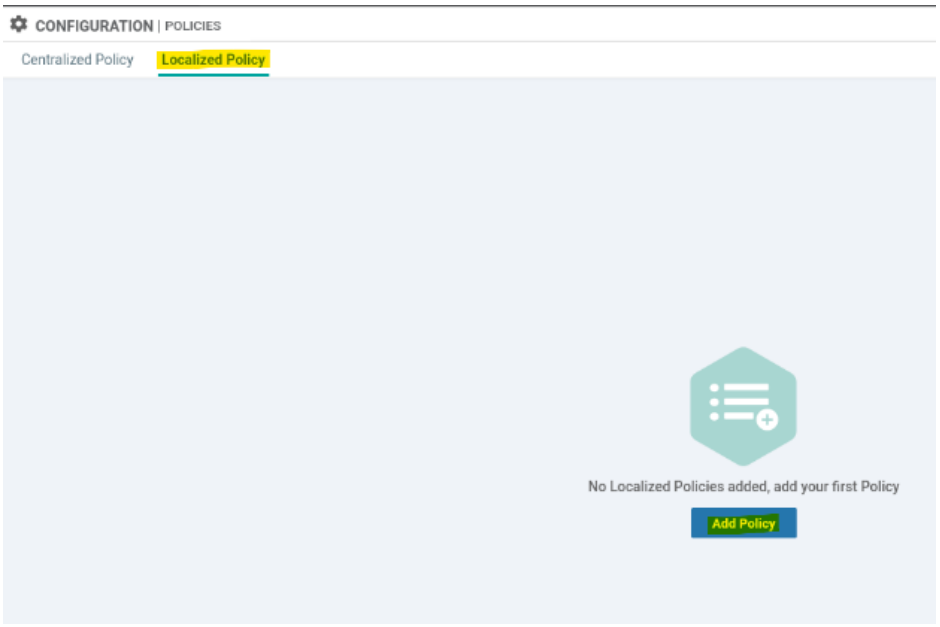
```
policy
 lists
  prefix-list DC-PREFIX
   ip-prefix 192.168.36.0/24
   ip-prefix 192.168.37.0/24
   ip-prefix 192.168.38.0/24
  !
  prefix-list DRC-PREFIX
   ip-prefix 192.168.26.0/24
   ip-prefix 192.168.27.0/24
   ip-prefix 192.168.28.0/24
  !
  prefix-list LAN-FACING-PREFIX
   ip-prefix 192.168.46.0/24
   ip-prefix 192.168.47.0/24
   ip-prefix 192.168.48.0/24
  !
 !
route-policy SET_LOCALPREF_RECEIVED_PREFIX
  sequence 5
   match
    address DRC-PREFIX
```

```
 !
 action accept
  set
   local-preference 1000          << All DRC prefixes entering will be set with a local preference of
 !                                   1000, for outbound traffic from the intranet/site Bandung.
sequence 10
 match
  address DC-PREFIX
 !
 action accept                    << accept prefix DC too, without set local pref
 !
!
 default-action reject
!
route-policy DONT_PASSING_USE_OTHER_PATH
 sequence 5
  match
   address LAN-FACING-PREFIX
  !
  action accept
   set
    as-path prepend 11111         << Adding an AS-path for inbound traffic to the intranet
  !                                  prefix, so the neighbor chooses a different path.
 default-action reject
!
vpn 2
router
 bgp 65040
  !
  neighbor 40.40.40.100
```

```
 description   To_SITE-BANDUNG2
 address-family ipv4-unicast
  route-policy SET_LOCALPREF_RECEIVED_PREFIX out
 !        ** If Site-Bandung wants outbound, the local preference to DRC-Cyber 2 is set to 1000, and for DC-DCI it
!             remains at the default.
neighbor 30.30.30.1
 description   To_vEdge-DC-DCI_eBGP
 address-family ipv4-unicast
  route-policy DONT_PASSING_USE_OTHER_PATH out
 !        ** If DC-DCI wants inbound traffic to Site Bandung, the AS-path will be added, causing DC-DCI to choose
!             vEdge-BDG2 (symmetric).
```

// vEdge-BDG2 (via Template)

1. Go to vManage, Configuration > Policies, then select 'Localized Policies'.

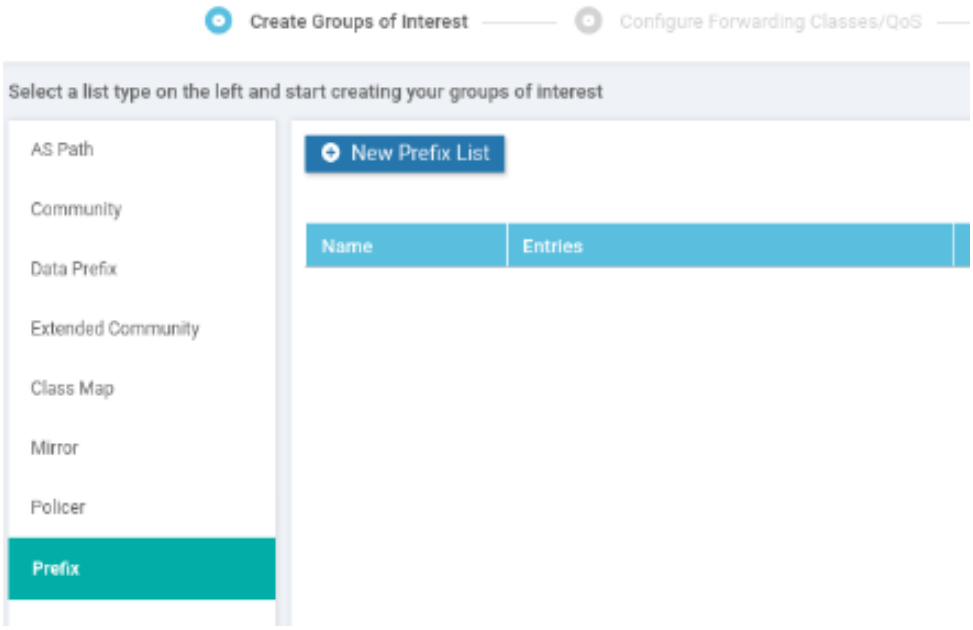


2. There are 5 sections (including overview) for 'Localized Policies', where we focus on the 'Group of Interest (Prefix)' and 'Configure Route Policy' sections only.

TION | POLICIES
Localized Policy > Add Policy
Create Groups of Interest
Configure Forwarding Classes/QoS
Configure Access Control Lists
Configure Route Policy
on the left and start creating your groups of interest

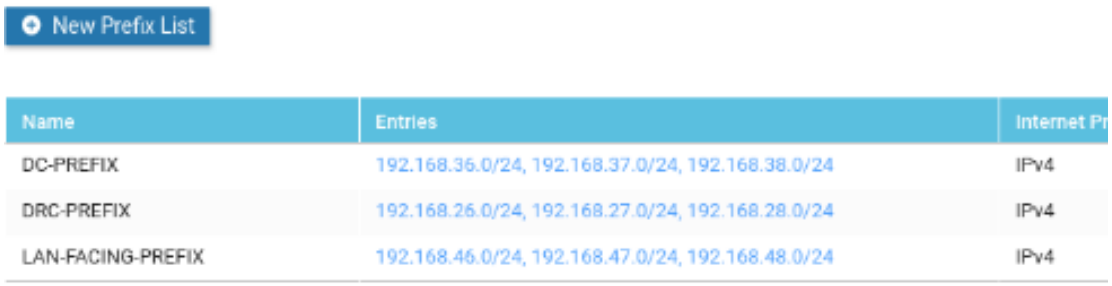
3. **[Create Groups of Interest]**

   There are several parameter lists we can use, but here we will use 'Prefix'. Go to this tab and select 'New Prefix List'.

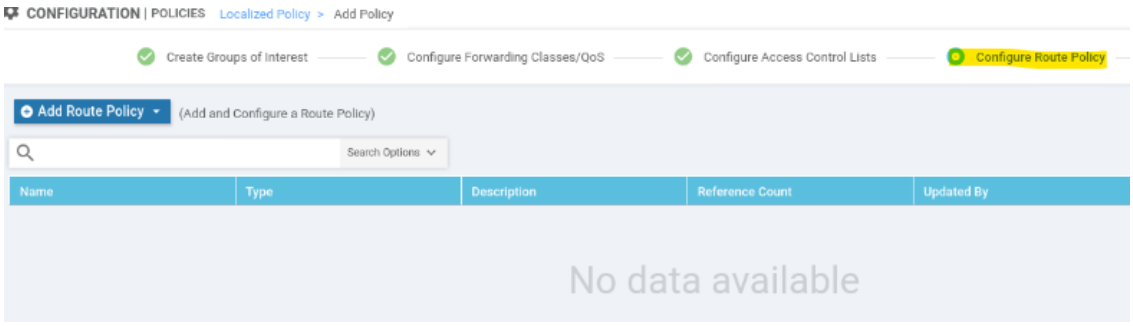


4. Add and categorize prefixes from each site (DC-DCI, DRC-Cyber2, Site-Bandung). For example, set up a prefix list for the DRC-Cyber2 site.

5. Complete all prefix lists from each site that will later be used for 'match address' in the route policy configuration

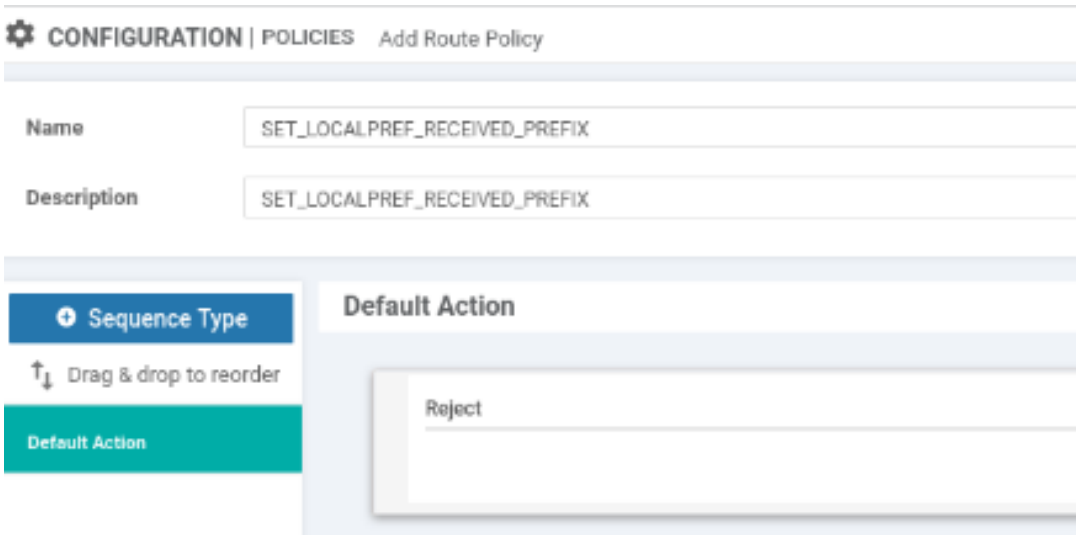


6. **[Create Route Policy]**
7. Next, go to the next section, skip the 'QoS' and 'ACL' sections, then in the 'Route Policy' section, add a route policy and select 'Create new'. Here, we'll create 2 policy 'SET_LOCALPREF_RECEIVED_PREFIX' and 'DONT_PASSING_USE_OTHER_PATH

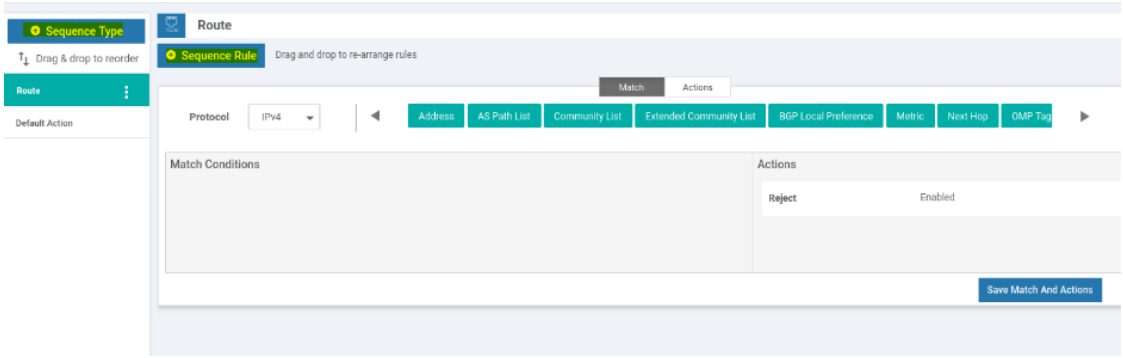


8. 'SET_LOCALPREF_RECEIVED_PREFIX'

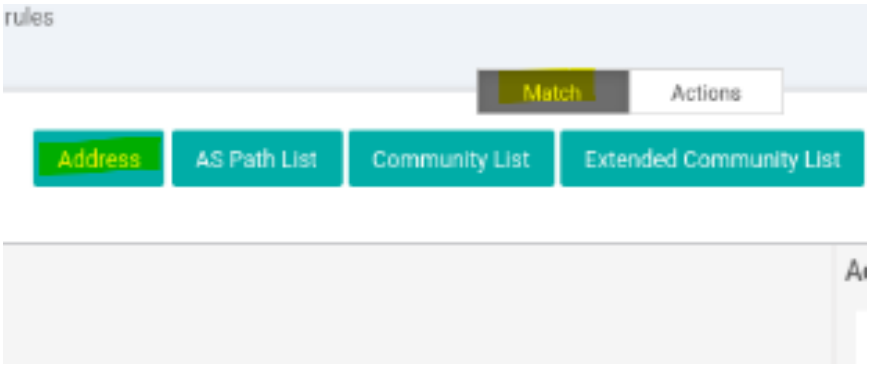
   This policy applies to outbound traffic from SITE-BANDUNG2, where it will change the local preference of prefixes received from DC-DCI to 1000 and accept prefixes from DRC-Cyber2 with the default local preference.



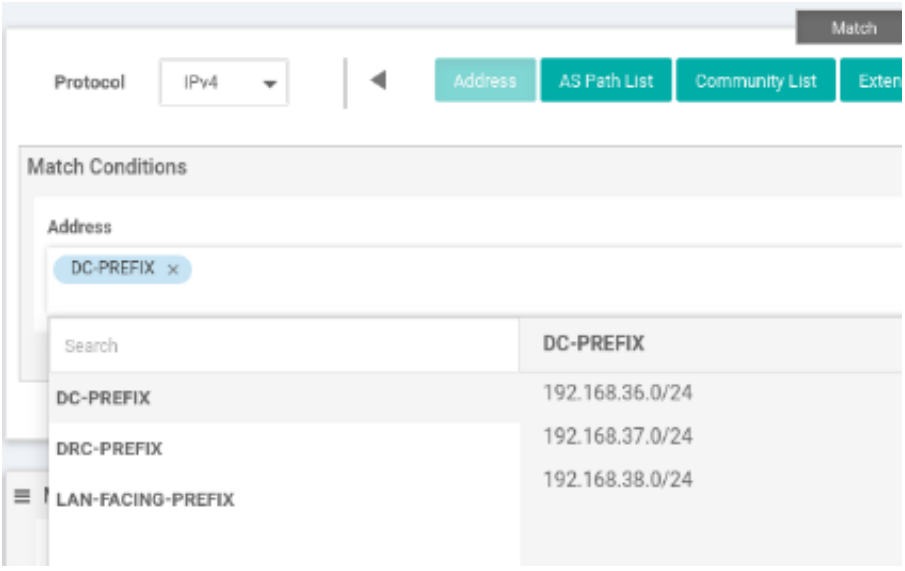
9. Click on ‘Sequence Type’ to add the order of policies to be applied, then click on ‘Sequence Rule’ to add rules to the policy.



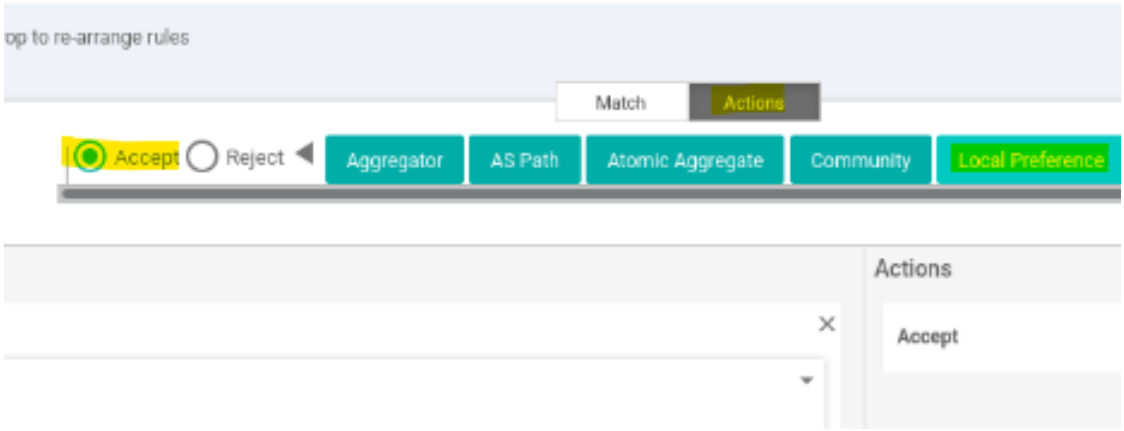
10. In the ‘Match’ menu, select the parameter Address.



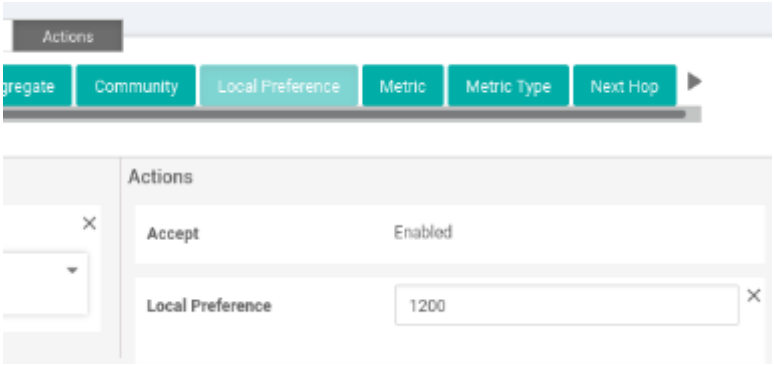
11. As intended, we will match the prefix list for DC-DCI that we will set its local preference.



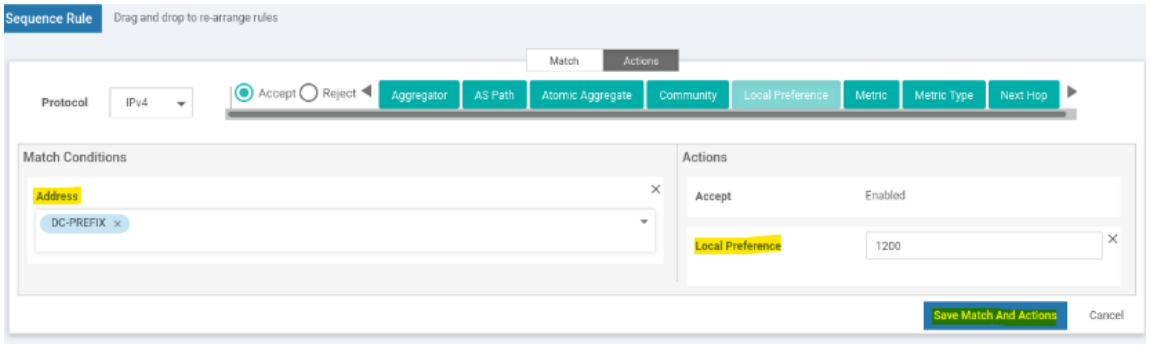
12. Next, move to the 'Actions' menu, select 'Accept', then select 'Local Preference'



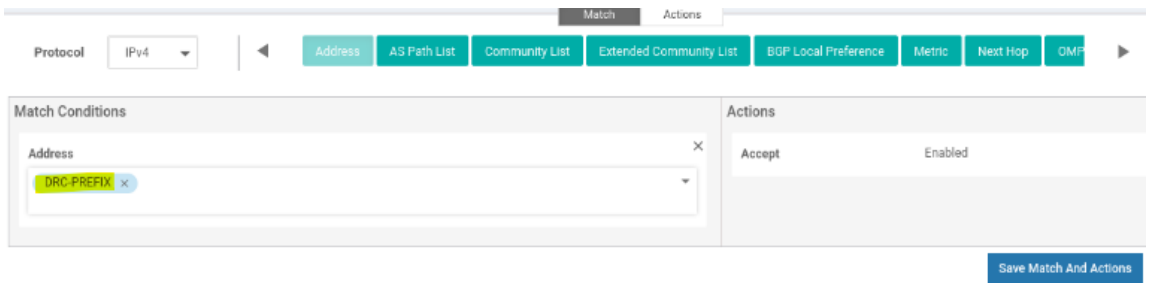
13. Determine the desired local preference value.



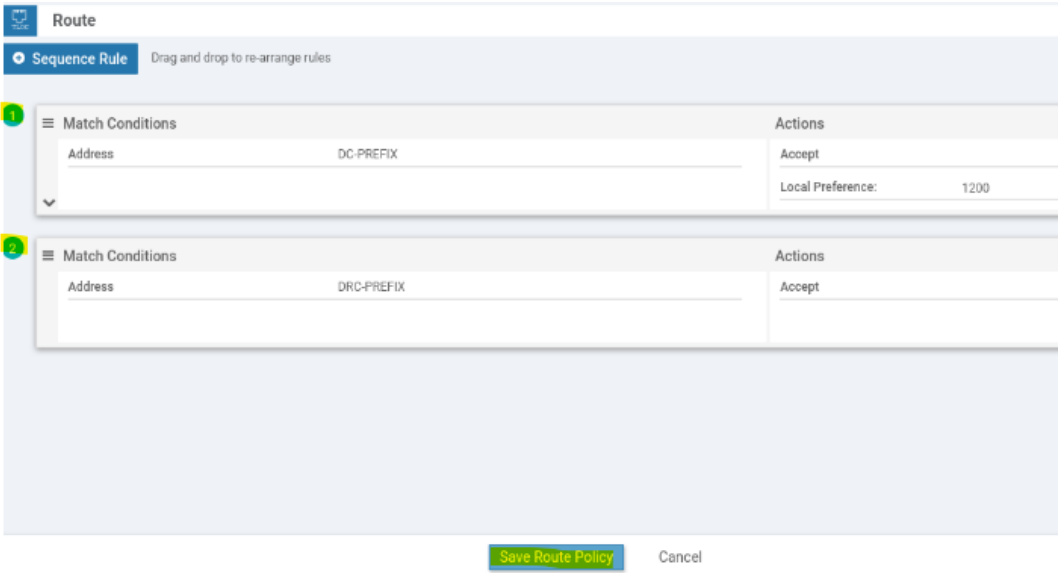
14. Click 'Save Match and Actions' when done.



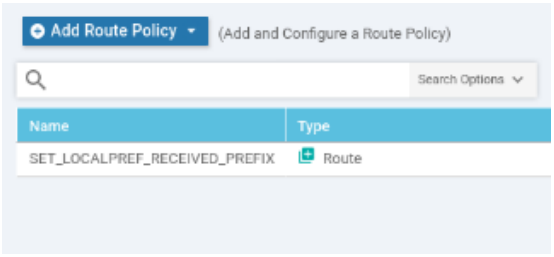
15. hen, add another 'Sequence Rule' to match DRC-PREFIX with the action accept without setting a parameter (default local pref).



16. Once the configuration and sequence order are correct, click 'Save Route Policy' at the end.

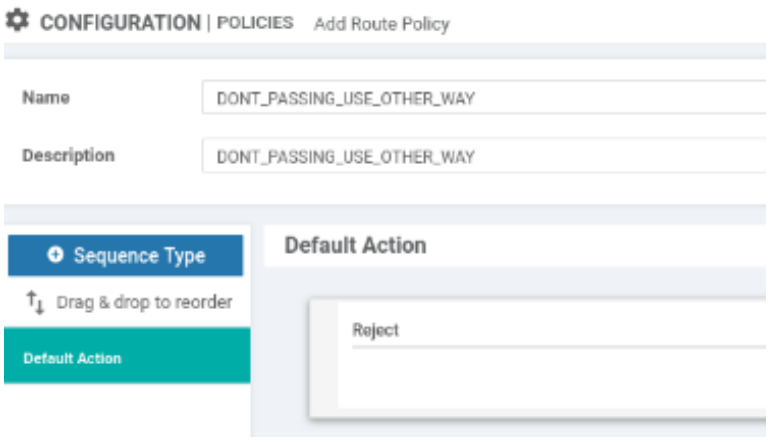


17. Go back to the section, then add the next route policy related to AS-path.

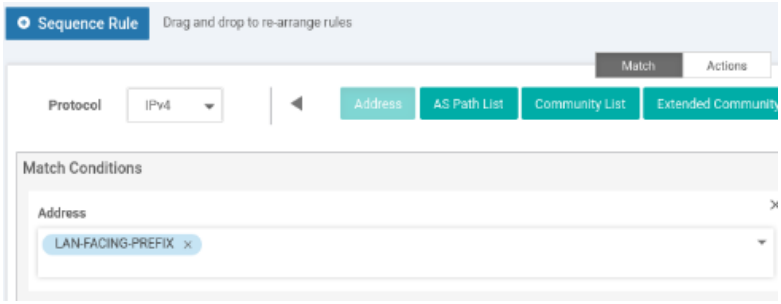


18. 'DONT_PASSING_USE_OTHER_PATH'

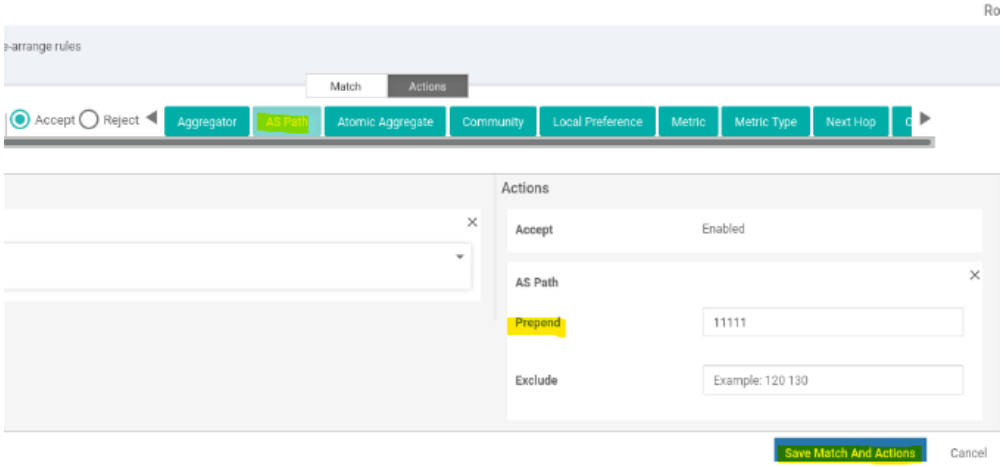
    This policy is sent to the neighbor DRC-Cyber2 to inform that to reach the prefix on SITE-BANDUNG2, they must go through the following AS-path (prepend). This makes DRC-Cyber2 choose another path (vEdge-BDG1), which is symmetric with outbound traffic (perspective SITE-BANDUNG2).



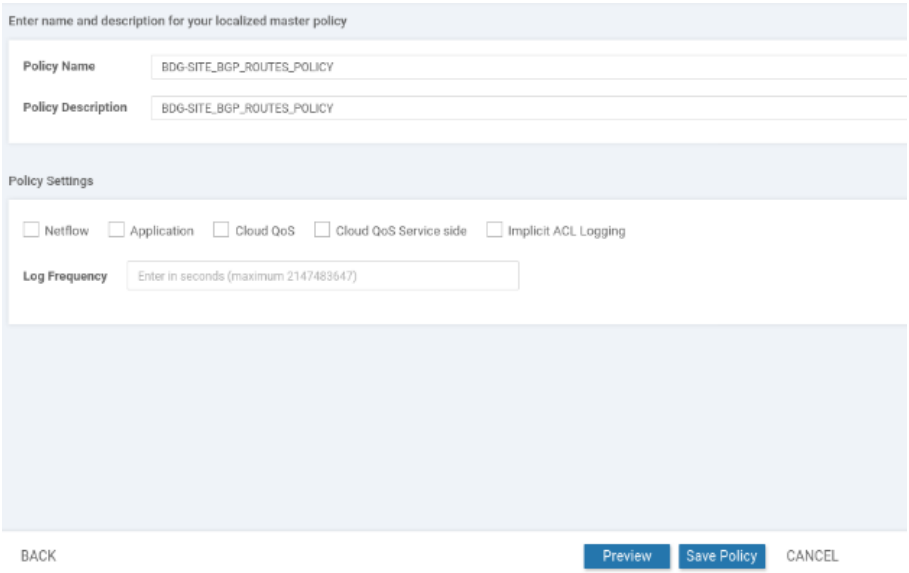
19. Add a ‘Sequence Type’ and then a ‘Sequence Rule’. In the ‘Match’ menu, select the prefix list ‘LAN-FACING-PREFIX’ (if DC-DCI is outbound to BANDUNG-SITE2, then the route policy will match).



20. Move to the ‘Actions’ menu, select ‘Accept’, then ‘AS-Path’, and input a fictitious AS-Path. Once done, click ‘Save Match and Actions’ and ‘Save Route Policy’.



21. Once everything is safe, click ‘Next’ and enter the Policy name to be included in the device template from the Bandung Site.

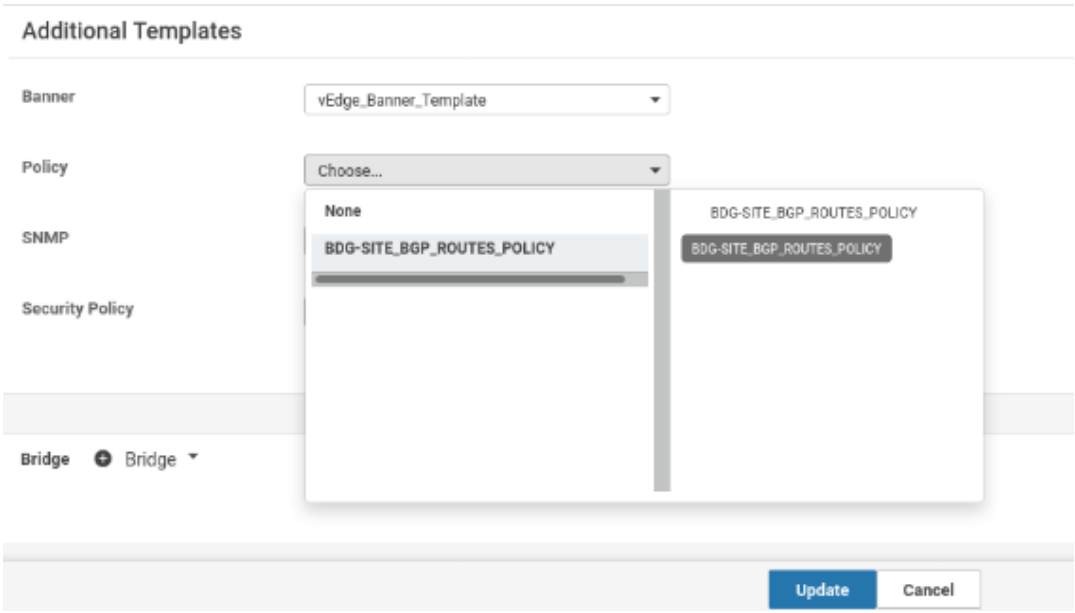


22. Perform a ‘Preview’ of the configuration that will be pushed to the device template. Once everything is safe, ‘Save Policy’.

```
route-policy SET_LOCALPREF_RECEIVED_PREFIX
 sequence 1
  match
   address DC-PREFIX
  !
  action accept
   set
    local-preference 1200
   !
  !
 !
 sequence 11
  match
   address DRC-PREFIX
  !
  action accept
  !
 !
 default-action reject
!
!
!
!
```

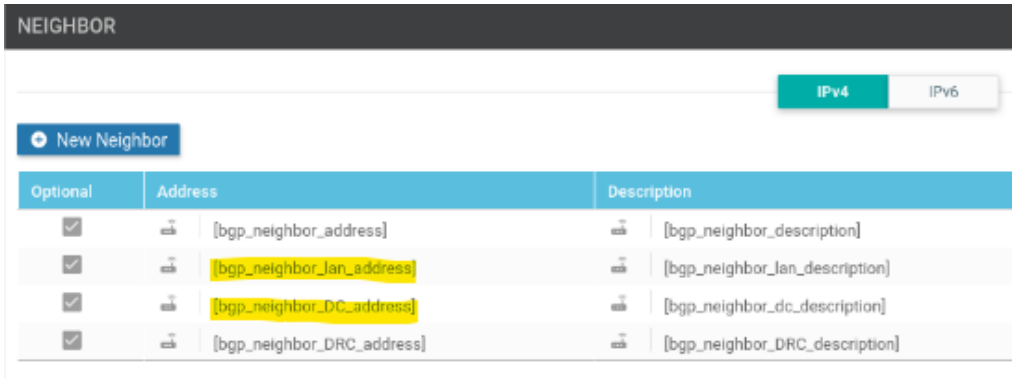
Back | Configure Devices | Cancel

23. With this, the policy has been created. Go to Configuration > Templates > Device Template, then edit the Bandung Site Device template, specifically in the ‘Additional Templates’ section, add the created policy, then ‘Update’.

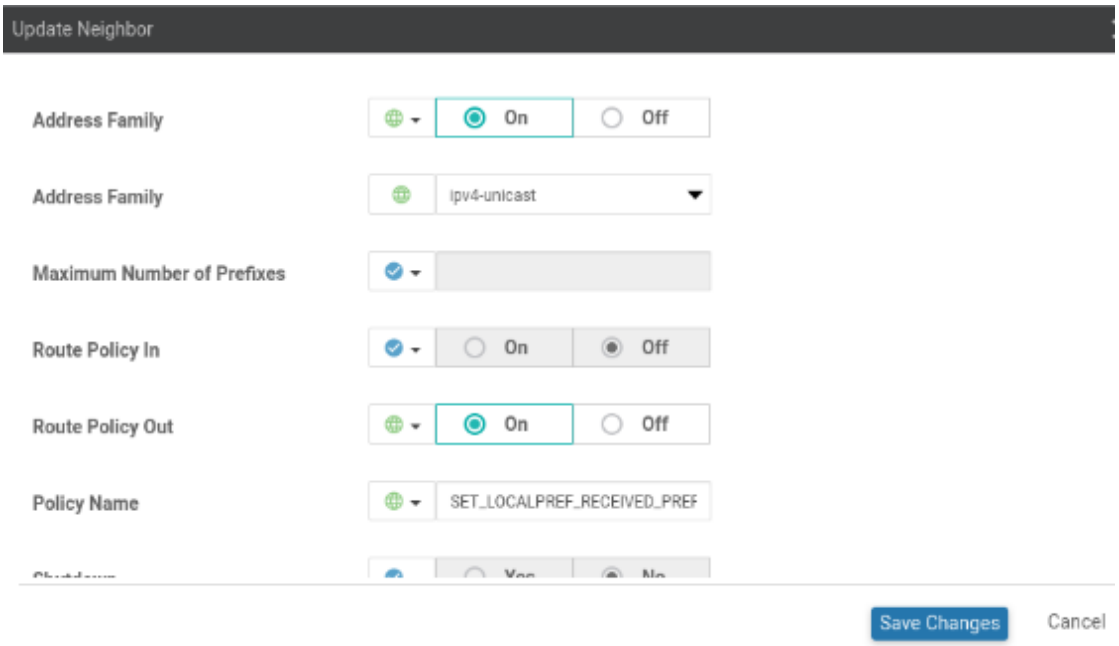


24. Perform the usual push procedure and don’t forget to verify the configuration first. If everything is correct, select ‘Configure Devices’, and the configuration will be successfully pushed to the device.

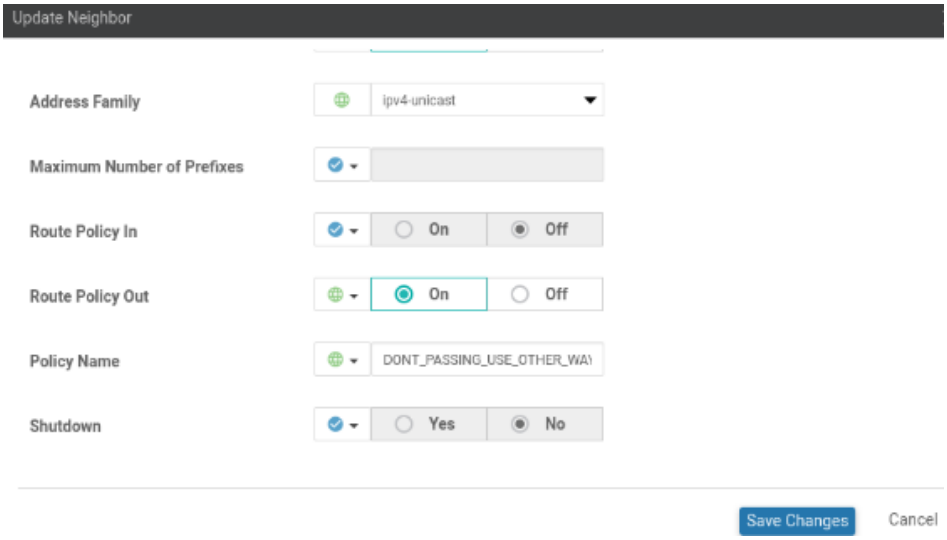
25. **[Apply route policy to BGP and specific neighbor]**
26. Finally, apply the route policy that has been created to specific neighbors. Go to the feature template, and edit the feature template Bandung Site VPN 2 BGP, then go to the 'Neighbor' section.



27. Edit the configuration of the SITE-BANDUNG2 neighbor, specifically in the address-family section and apply the policy 'SET_LOCALPREF_RECEIVED_PREFIX' with outbound traffic, then enter the name of route policy. If done, click 'Save Changes'

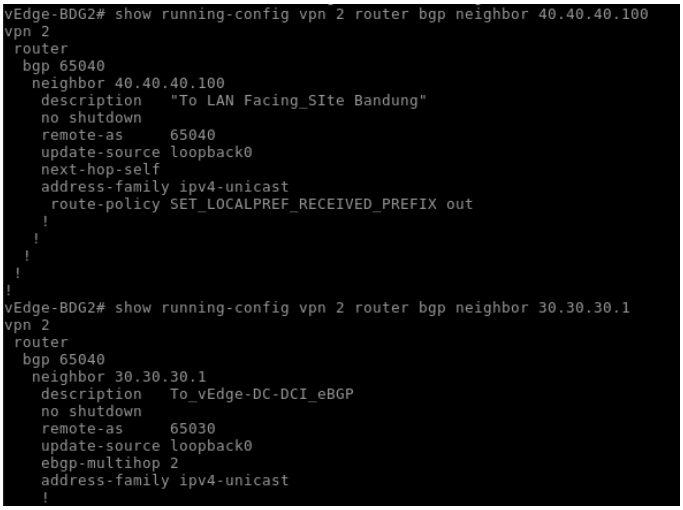


28. Similarly, edit the configuration for the neighbor directed to DRC-Cyber2 and enter the route policy 'DONT_PASSING_USE_OTHER_PATH', choose outbound traffic then enter the name of the route policy. Once done, click 'Save Changes'.



29. If everything is done, click 'Update' on the feature template, then follow the usual device push procedure, and verify the configuration before pushing.

30. Dengan demikian route policy via template untuk vEdge-BDG2 berhasil dikonfigurasi



VPN 2 : BGP Route Policy Verification

// show ip bgp (SITE-BANDUNG2)

```
SITE-BANDUNG2#show ip bgp
BGP table version is 46, local router ID is 40.40.40.100
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 * i  192.168.26.0     40.40.40.2               11    100      0 65020 i
 *>i                   40.40.40.1               11   1000      0 65020 i
 * i  192.168.27.0     40.40.40.2               11    100      0 65020 i
 *>i                   40.40.40.1               11   1000      0 65020 i
 * i  192.168.28.0     40.40.40.2               11    100      0 65020 i
 *>i                   40.40.40.1               11   1000      0 65020 i
 * i  192.168.36.0     40.40.40.1                     100      0 65030 i
 *>i                   40.40.40.2                    1200      0 65030 i
 * i  192.168.37.0     40.40.40.1                     100      0 65030 i
 *>i                   40.40.40.2                    1200      0 65030 i
 * i  192.168.38.0     40.40.40.1                     100      0 65030 i
 *>i                   40.40.40.2                    1200      0 65030 i
```

DRC-Cyber2 (192.168.2x.0) through 40.40.40.1 (vEdge-BDG1) with local preference 1000

DRC-Cyber2 (192.168.2x.0) through 40.40.40.2 (vEdge-BDG2) with local preference 1200

// show bgp routes (vEdge-DRC-Cyber2 & vEdge-DC-DCI)

```
vEdge-DRC-Cyber2# show bgp routes 192.168.46.0/24
bgp routes-table vpn 2 192.168.46.0/24
 info 0
  nexthop      40.40.40.1
  weight       0
  origin       igp
  as-path      65040
  path-status  valid,best,external
  tag          0
  ospf-tag     0
 info 1
  nexthop      40.40.40.2
  weight       0
  origin       igp
  as-path      "65040 11111"
  path-status  valid,external
  tag          0
  ospf-tag     0
```

vEdge-DRC-Cyber2 choose 40.40.40.1 (vEdge-BDG1) for inbound to SITE-BANDUNG2 (symetric)

```
vEdge-DC-DCI# show bgp routes 192.168.46.0/24
bgp routes-table vpn 2 192.168.46.0/24
 info 0
  nexthop     40.40.40.1
  weight      0
  origin      igp
  as-path     "65040 11111"
  path-status valid,external
  tag         0
  ospf-tag    0
 info 1
  nexthop     40.40.40.2
  weight      0
  origin      igp
  as-path     65040
  path-status valid,best,external
  tag         0
  ospf-tag    0
```

vEdge-DC-DCI choose 40.40.40.2 (vEdge-BDG2) for inbound to SITE-BANDUNG2 (symetric)

// traceroute (SITE-BANDUNG2)

```
SITE-BANDUNG2#traceroute 192.168.26.10
Type escape sequence to abort.
Tracing the route to 192.168.26.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.42.1 6 msec 21 msec 21 msec
  2 20.20.20.1 51 msec 47 msec 54 msec
  3 172.16.22.10 51 msec 61 msec *
```

Destination to DRC-Cyber2 with next-hop 172.16.42.1 (vEdge-BDG1/40.40.40.1)

```
SITE-BANDUNG2#traceroute 192.168.36.10
Type escape sequence to abort.
Tracing the route to 192.168.36.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.42.2 15 msec 6 msec 20 msec
  2 30.30.30.1 42 msec 48 msec 41 msec
  3 172.16.32.3 68 msec 57 msec *
```

Destination to DC-DCI with next-hop 172.16.42.2 (vEdge-BDG2/40.40.40.2)

VSMART TEMPLATE SETUP AND OVERVIEW

Centralized Policies & Hub and Spoke Setup

Centralized Policies Overview

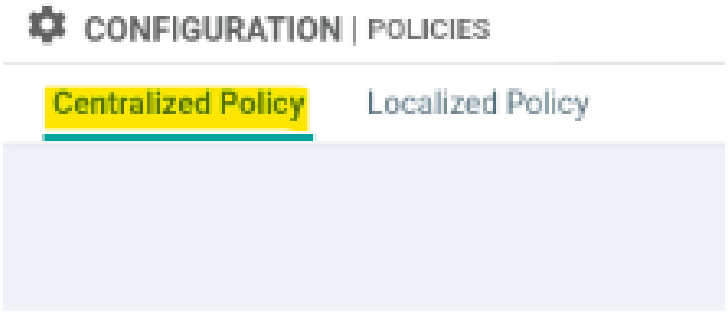
If in the previous BGP route policy we used **'Localized Policies'**, there are also **'Centralized Policies'** that can be used for implementation through the vSmart template. The differences between these two methods are as follows:

- **Localized Policies,** Configured directly on the vEdge device itself or locally without affecting other devices. This includes the application of lists, ACL, route policies, QoS, etc.
- **Centralized Policies,** This can be applied as Control and Data Policies, where Control Policies can influence the operation of the next-hop or OMP that forwards traffic, while Data Policies can affect data plane traffic, such as QoS for global vEdge configuration.

Centralized Policies are defined on vManage, then pushed to vSmart, which subsequently pushes them to vEdge. These policies are pushed to all OMP peerings and impact how vEdge handles traffic. When creating control or data policies on vManage, these policies are sent to vSmart. Therefore, it is necessary to set up a device template for vSmart.

What Is Inside Centralized Policies?

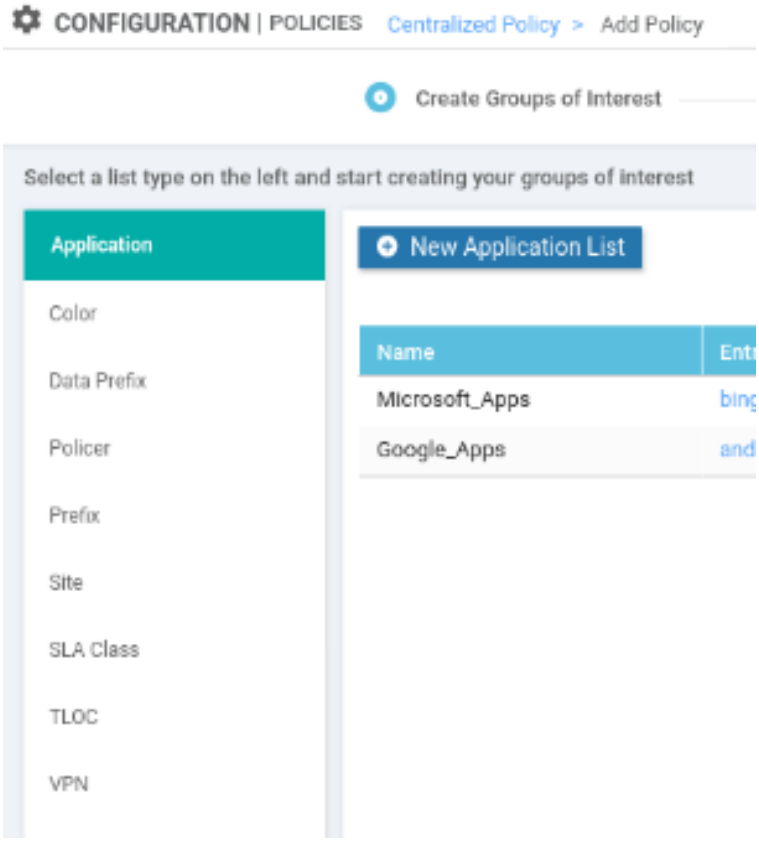
In the **'Configuration > Policies'** menu, there are two policy methods: **Centralized Policy** and **Localized Policy**. We will focus on **Centralized Policy**. Click on **'Add Policy'**.



Within **Centralized Policies**, there are four sections that can be configured and applied globally to vEdge devices. These sections include:

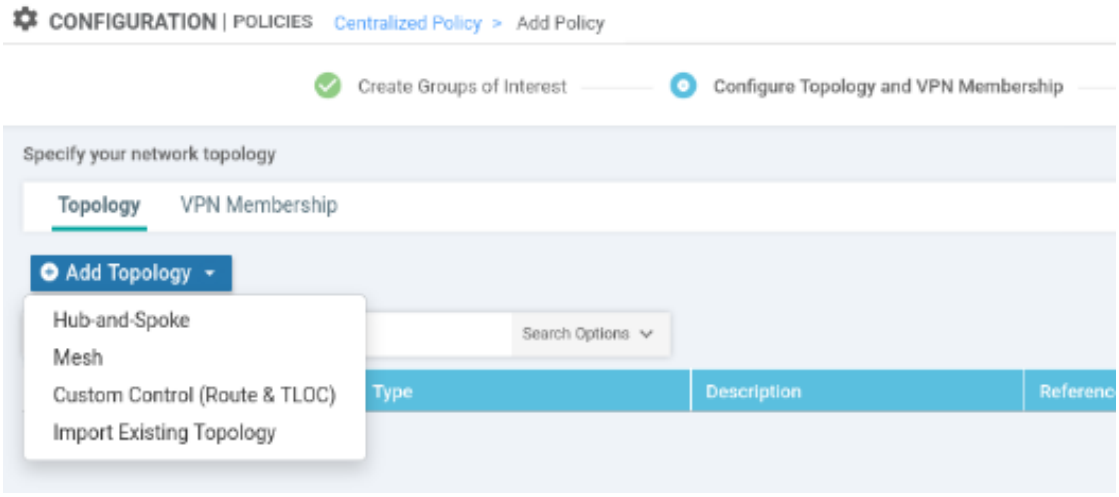
a. **Create Group of Interest**

This section allows us to define several elements to match and apply to policies, such as Applications, Colors, Prefixes, Sites, and more.

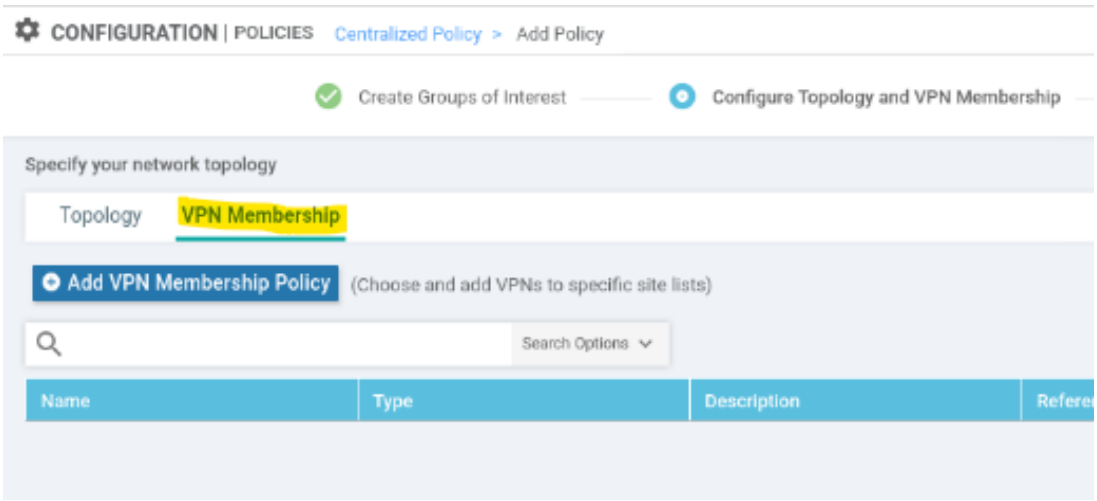


b. **Configure Topology and VPN Membership**

Here, we can control how traffic is forwarded across the backbone and other networks. It includes configurations like Hub and Spoke, Mesh, and Custom Control (Route & TLOC).

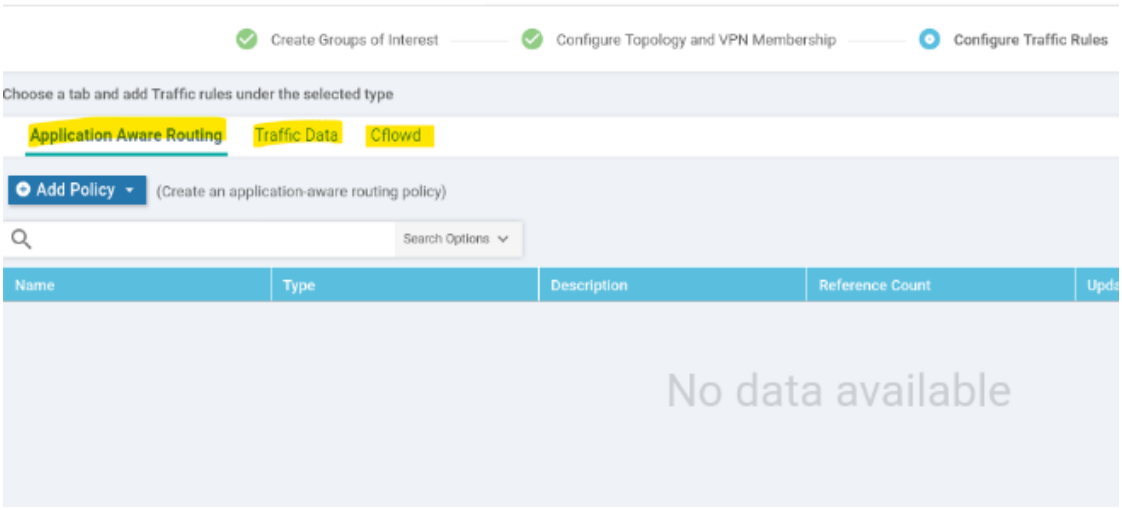


Additionally, in the **'VPN Membership'** tab, we can add or manage policies related to which VPNs are allowed to communicate with each other.

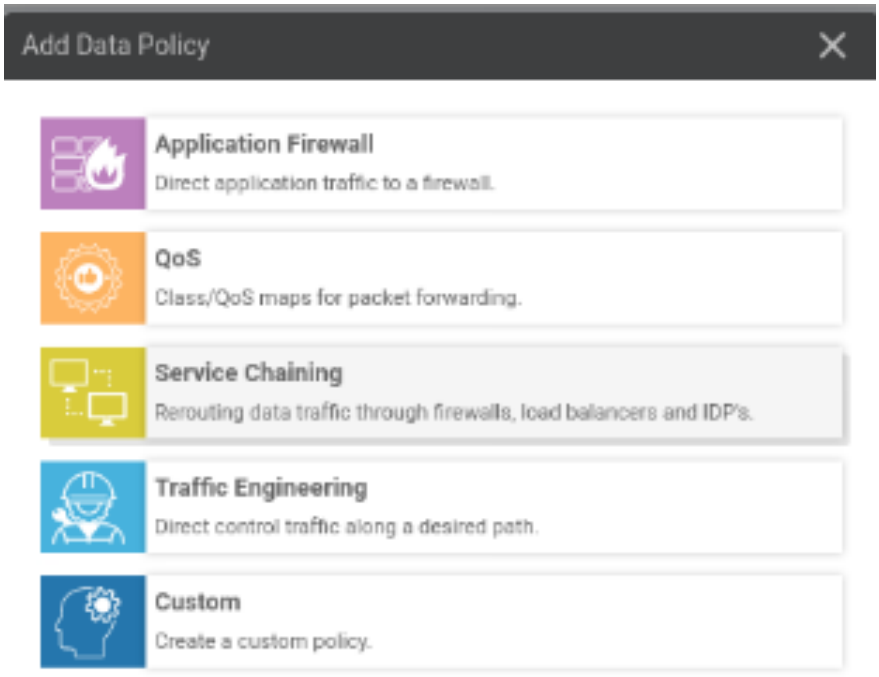


c. Configure Traffic Rules

This section allows the use of **'Application Aware Routing'** to monitor network path quality in real time. We can then implement policies for data traffic and configure NetFlow or cFlow as needed.

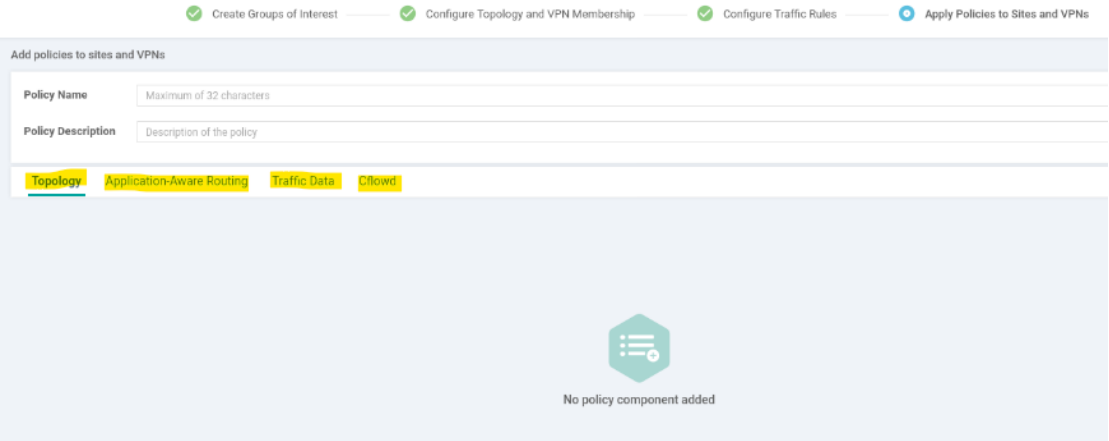


For instance, in traffic data policies, we can define rules such as redirecting traffic to a firewall, applying traffic engineering, and more.



d. **Apply Policies to Sites and VPN's**

Finally, this section allows us to review the policies to be implemented. This is where we finalize and ensure the previously defined policies are correctly applied.

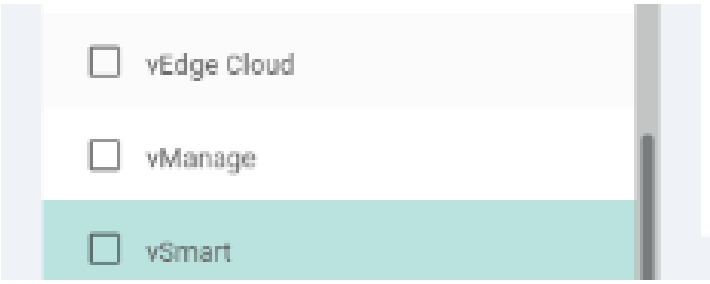


vSmart Template Setup

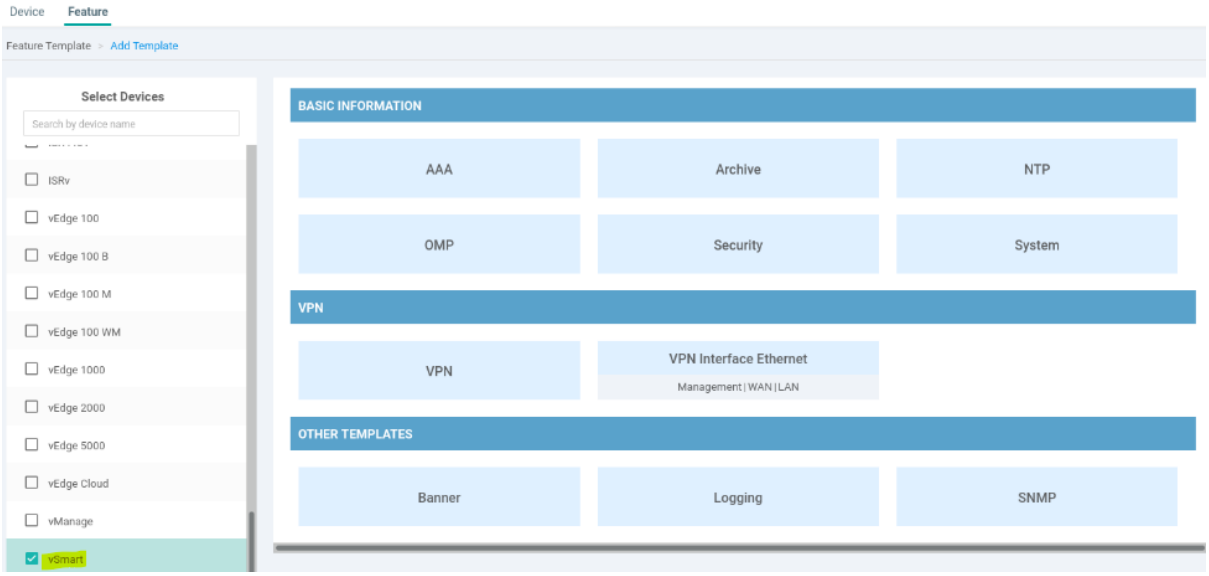
Create a basic feature template similar to the previous one that will be applied to the device template for vSmart, consisting of:

1. System
2. Banner
3. VPN 0 (Default Route to PE_Gateway)
4. VPN 0 Interface
5. VPN 512
6. VPN 512 Interface

Don't forget to change the device model, where previously we used 'vEdge Cloud,' but for this template, we will use vSmart.

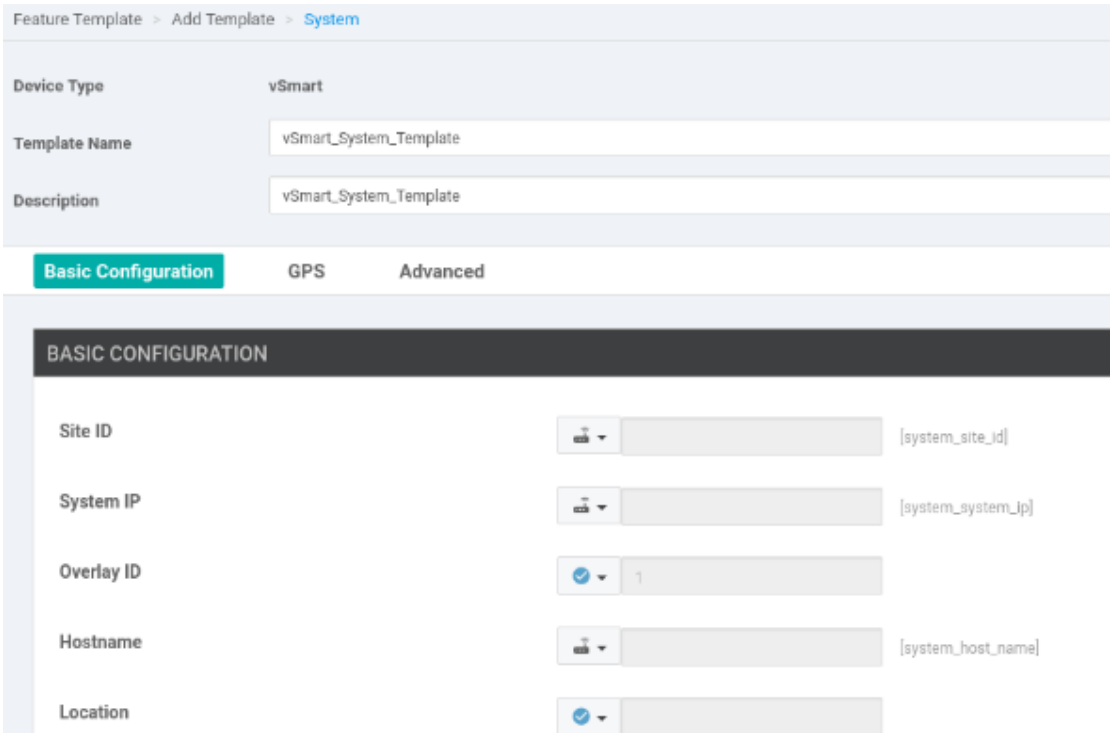


For the vSmart device model, the configurations that can be applied are not as extensive as those available for the vEdge Cloud.

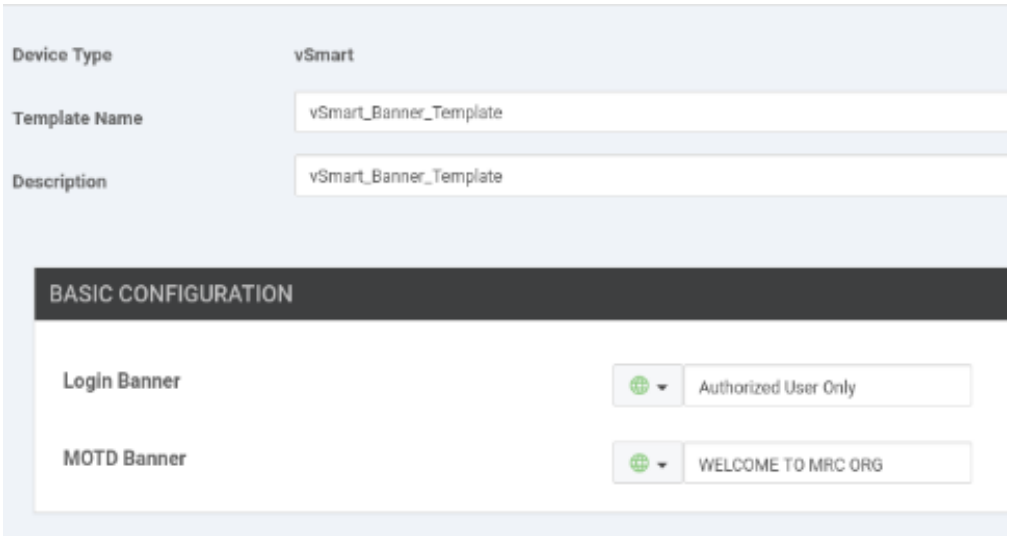


Template Setup:

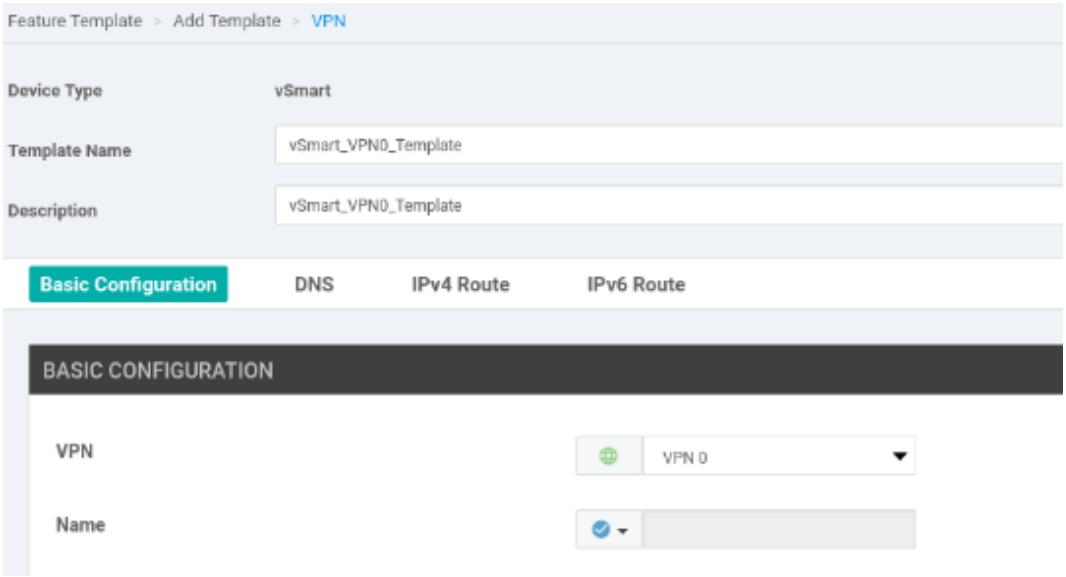
1. [System Template]



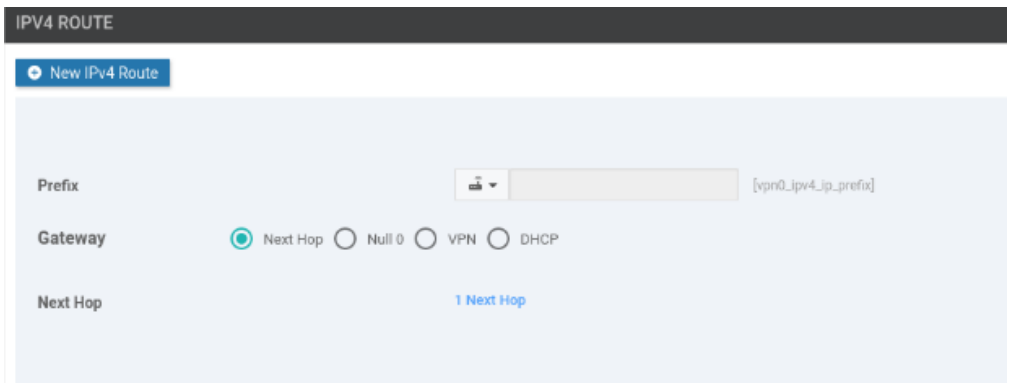
2. [Banner]



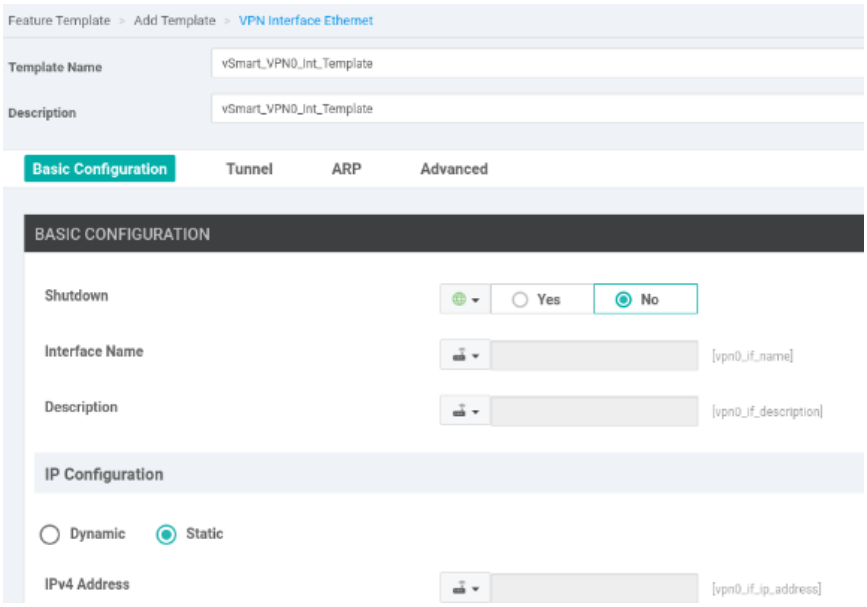
3. [VPN 0]



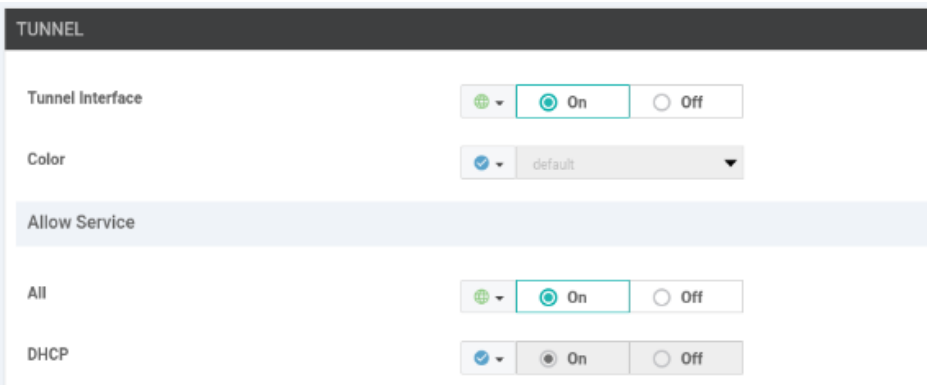
4. Add the IPv4 route with the next-hop to the PE_Router, setting it as a device-specific configuration.



5. [VPN 0 Interface]

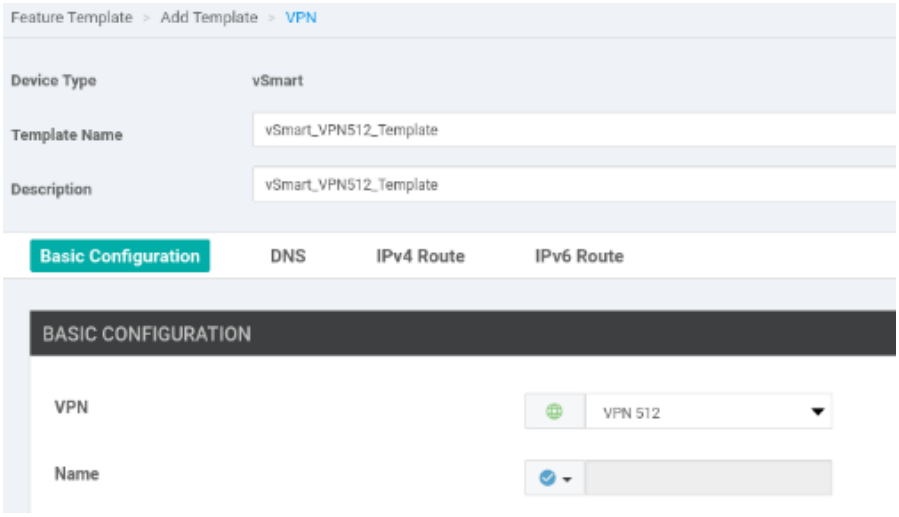


6. Enable tunnel interface to 'Allow-Service' all

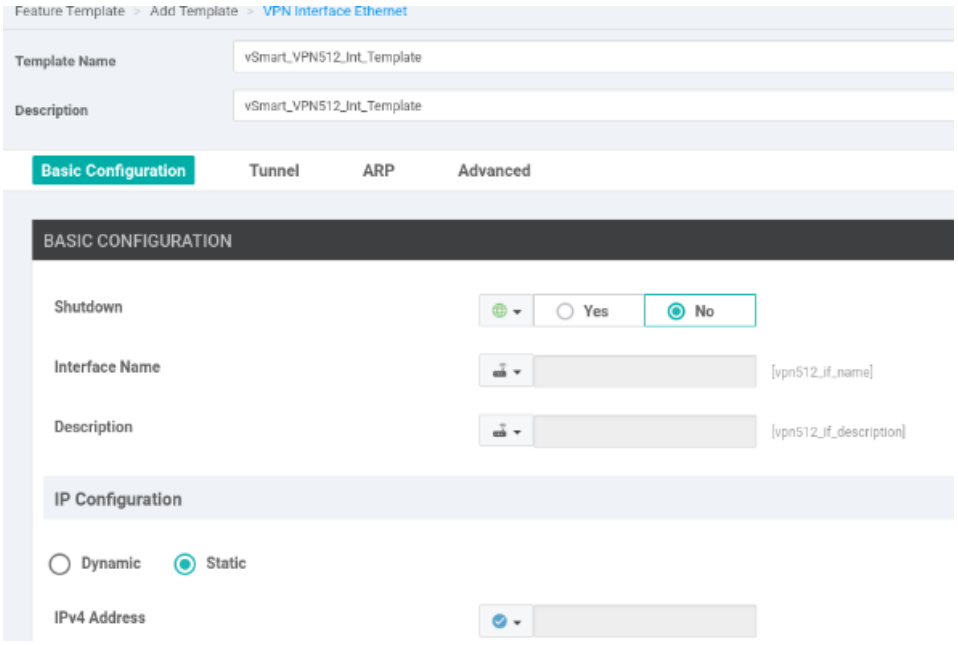


7. [VPN 512]

   Create a feature template for VPN 512 without an IPv4 route.



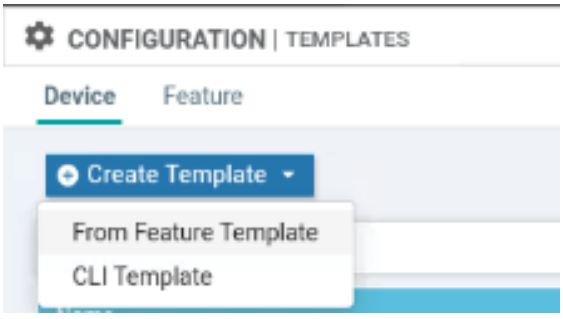
8. [VPN 512 Interface]



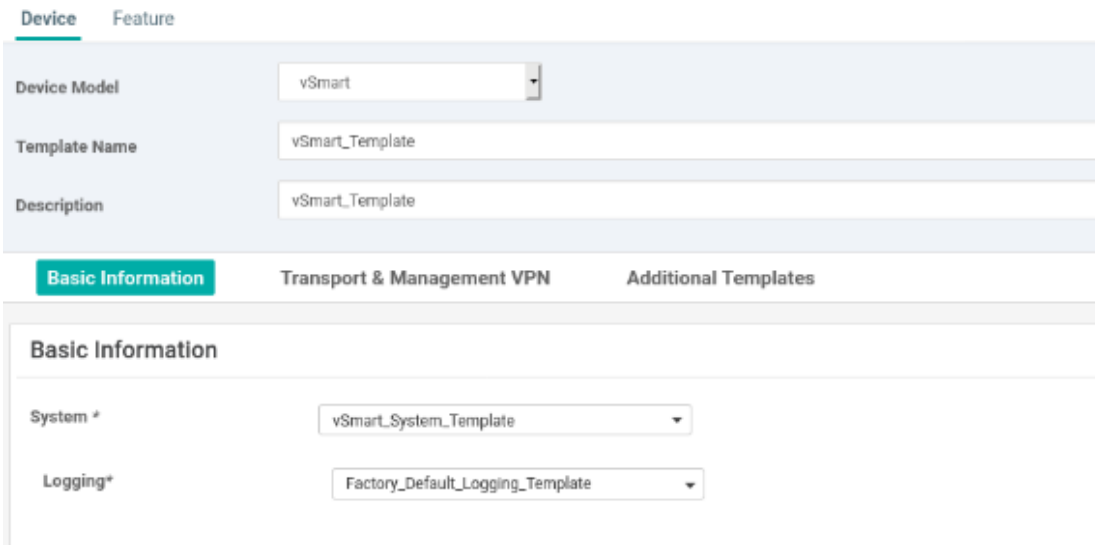
9. With the feature template for vSmart ready, it is now ready to be applied to the device template.

Name	Description	Type	Device Model
vSmart_VPN512_Template	vSmart_VPN512_Template	vSmart VPN	vSmart
vSmart_VPN512_Int_Template	vSmart_VPN512_Int_Templ...	vSmart Interface	vSmart
vSmart_VPN0_Template	vSmart_VPN0_Template	vSmart VPN	vSmart
vSmart_VPN0_Int_Template	vSmart_VPN0_Int_Template	vSmart Interface	vSmart
vSmart_System_Template	vSmart_System_Template	vSmart System	vSmart
vSmart_Banner_Template	vSmart_Banner_Template	Banner	vSmart

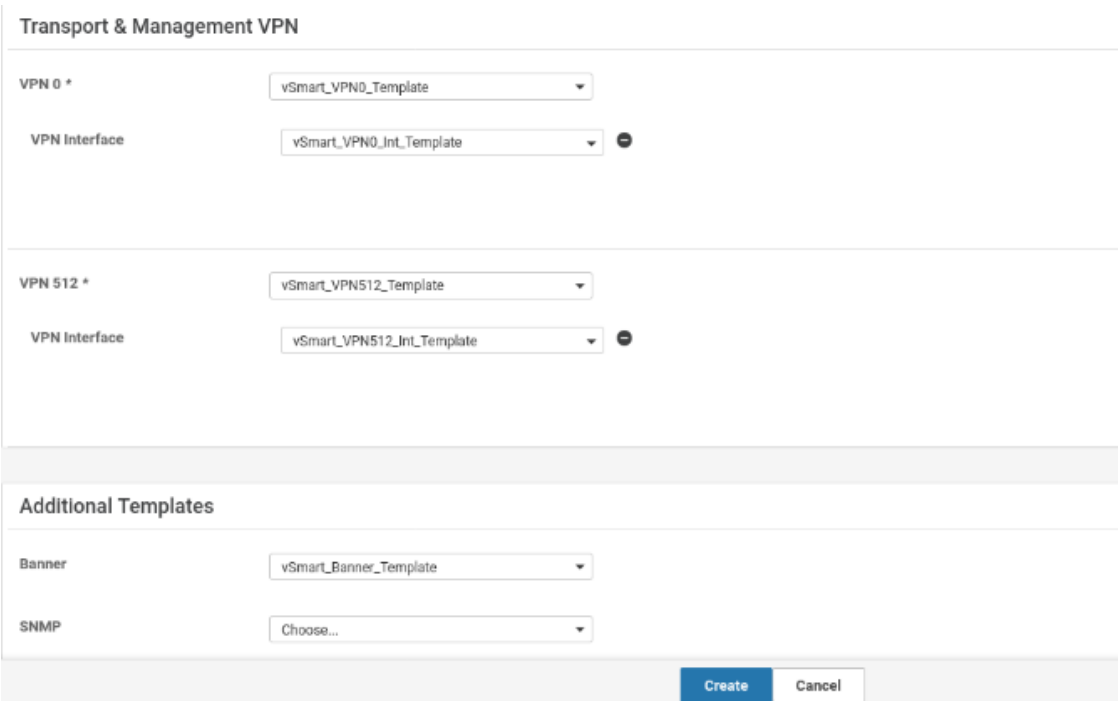
10. Go to Configuration > Template > Device, then ‘Create Template’ for the device template.



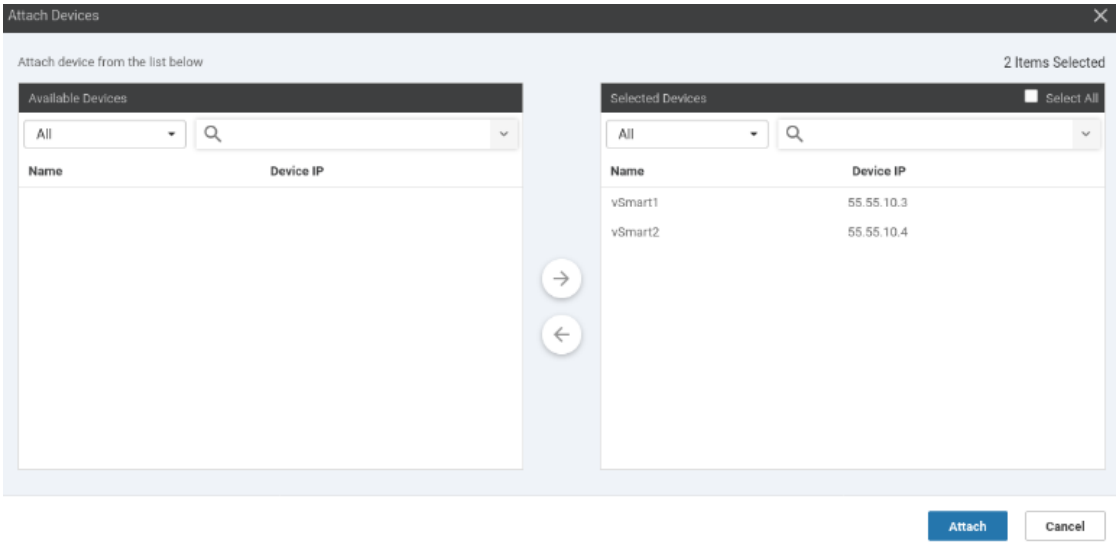
11. Enter the template name and system feature template.



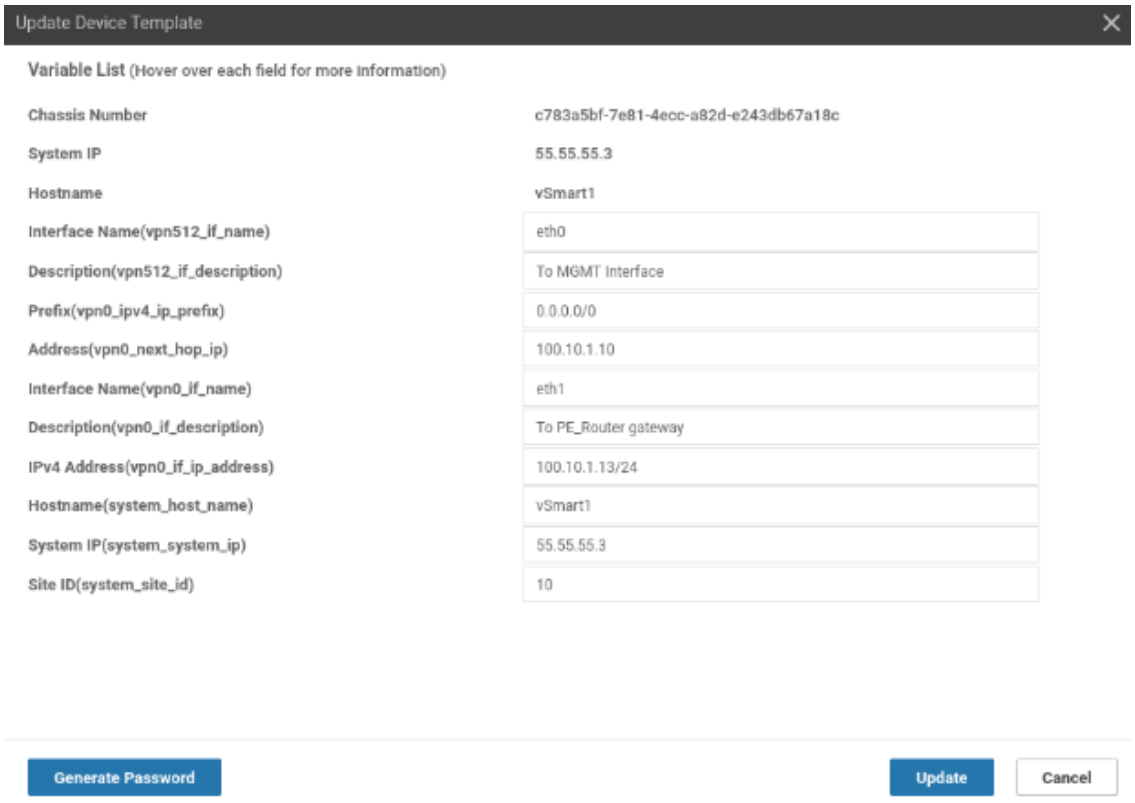
12. In the 'Transport & Management VPN' section, also include the VPN 0 and VPN 512 templates that have been created, then 'Create'.



13. Attach the device to the device template by moving the vSmart to the right, then 'Attach'.



14. Edit both vSmart devices according to the required parameter values, then 'Update' and 'Next'.



15. Verify the configuration before pushing it to the devices. Once it is safe, select 'Configure Devices'.

```
vpn 0
 interface eth1
  description "To PE_Router gateway"
  ip address 100.10.1.13/24
  tunnel-interface
   allow-service all
   allow-service dhcp
   allow-service dns
   allow-service icmp
   no allow-service sshd
   no allow-service netconf
   no allow-service ntp
   no allow-service stun
  !
  no shutdown
 !
 ip route 0.0.0.0/0 10.100.1.10
!
```

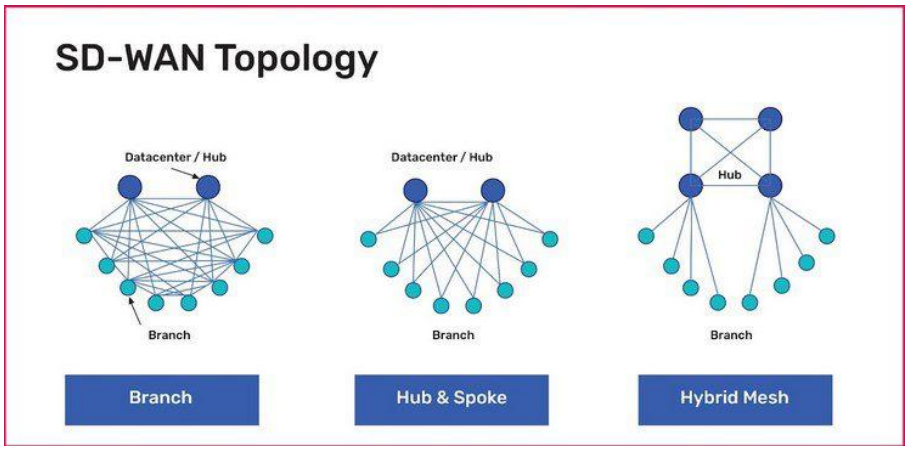
Back | Configure Devices | Cancel

16. As a result, the configuration from the device template is successfully pushed to vSmart, and both vSmart devices are now managed by vManage. Now, vSmart can be configured with Centralized Policies.

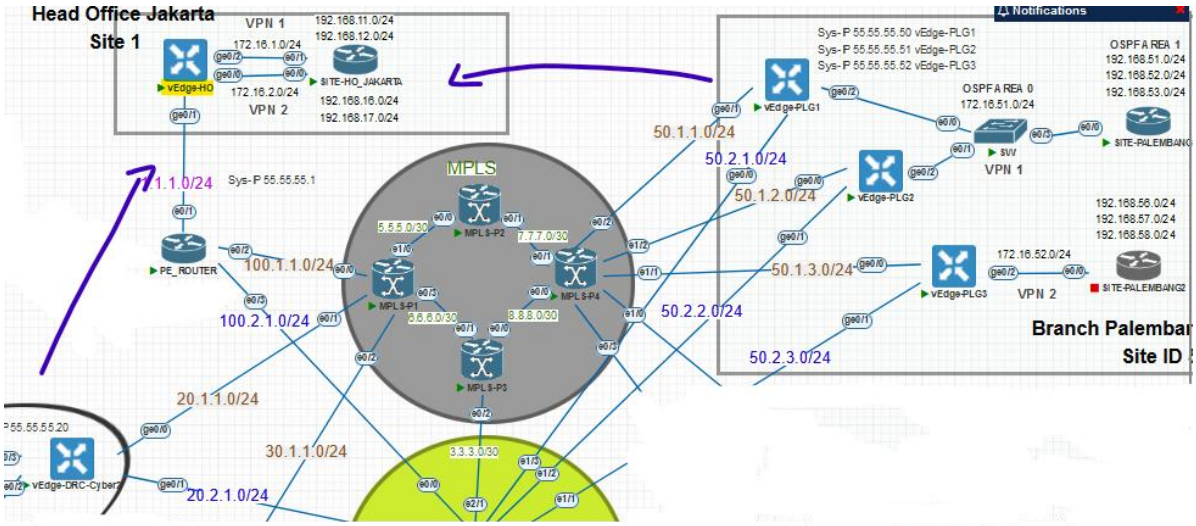
```
vSmart1# show run vpn 0
vpn 0
 interface eth1
  description "To PE_Router gateway"
  ip address 100.10.1.13/24
  tunnel-interface
   allow-service all
   allow-service dhcp
   allow-service dns
   allow-service icmp
   no allow-service sshd
   no allow-service netconf
   no allow-service ntp
   no allow-service stun
  !
  no shutdown
 !
 ip route 0.0.0.0/0 100.10.1.10
!
```

Hub & Spoke Setup

If previously, the connection between vEdge was established with a 'Spoke-to-Spoke' or Branch-to-Branch model through IPSec tunnels, with the application of Centralized Policies, we can control each traffic between vEdges to become 'Hub & Spoke'. This type of model is a network architecture used to connect various locations or branches to a central point (Hub). Therefore, all communications between vEdge (branch-to-branch) must go through the Hub (head office).



Skenario:



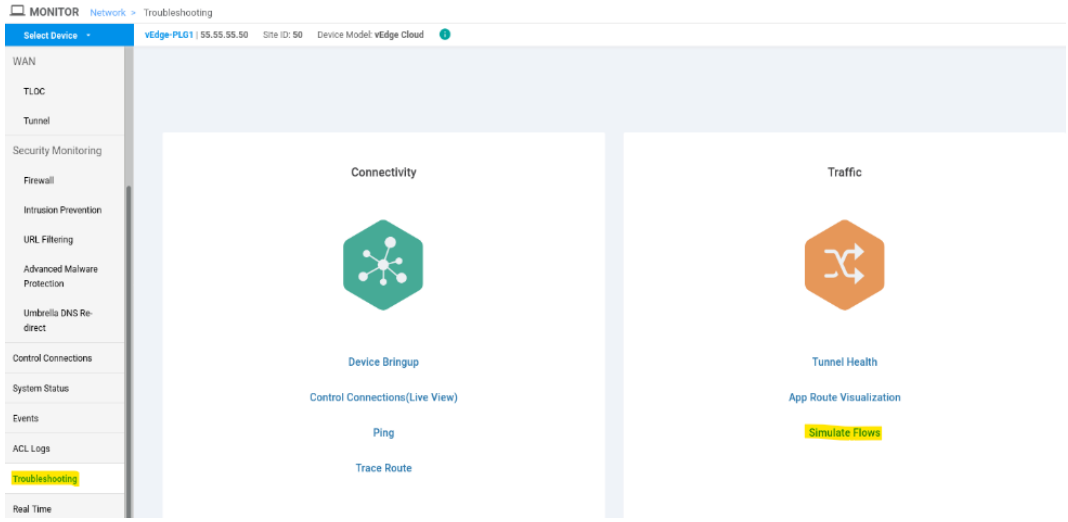
If by default, each vEdge formed direct communication with each other (full-mesh), here we will configure that each vEdge (Spoke) must go through the Hub first before communicating with another vEdge.

Here, **vEdge-HO** will act as the **Hub**, and all vEdge at **Palembang-Site** and **vEdge-DRC-Cyber2** will be **Spokes.**

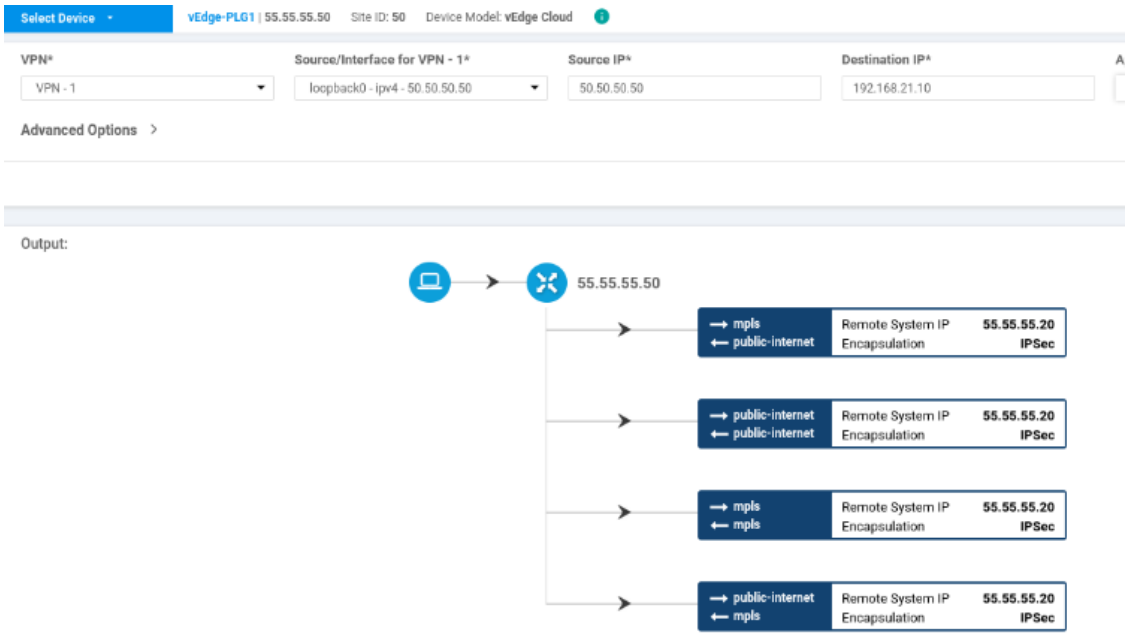
Step-by-step:

// Before scenario

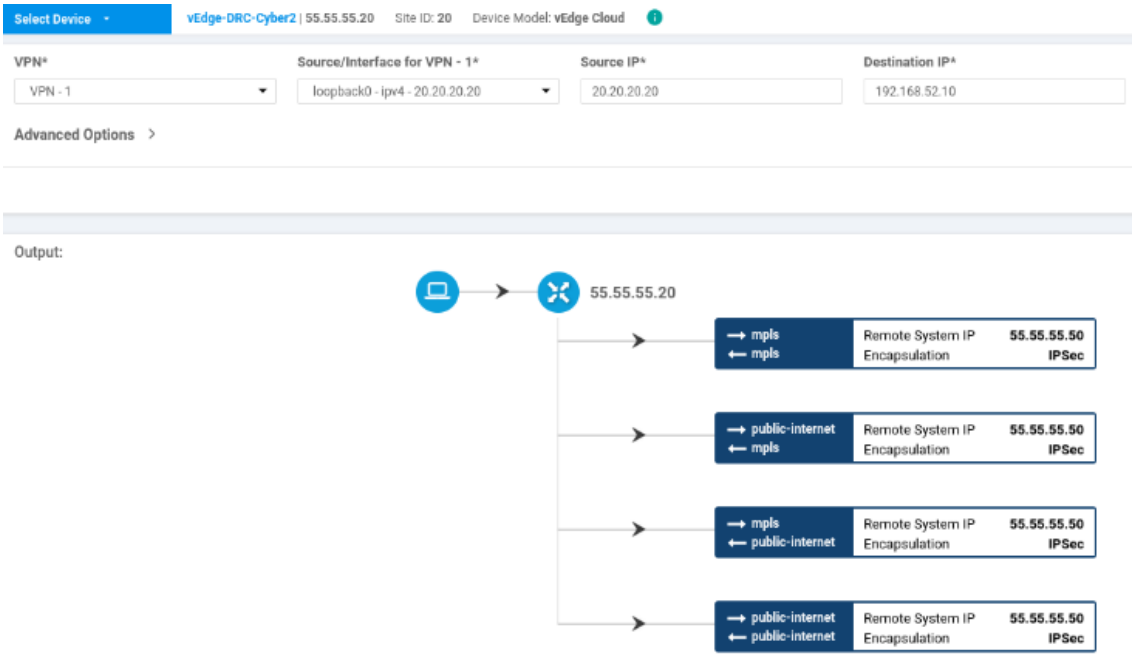
1. We will perform a traceroute from vEdge-PLG to vEdge-DRC-Cyber2. In vManage, go to Monitor > Network, select the device, then choose the Troubleshooting menu, and finally 'Simulate Flows'.



2. Specify the VPN, Source Interface/IP, and Destination IP, then click 'Simulate'. This allows us to directly see the traffic flow to vEdge-DRC-Cyber2 (Spoke).



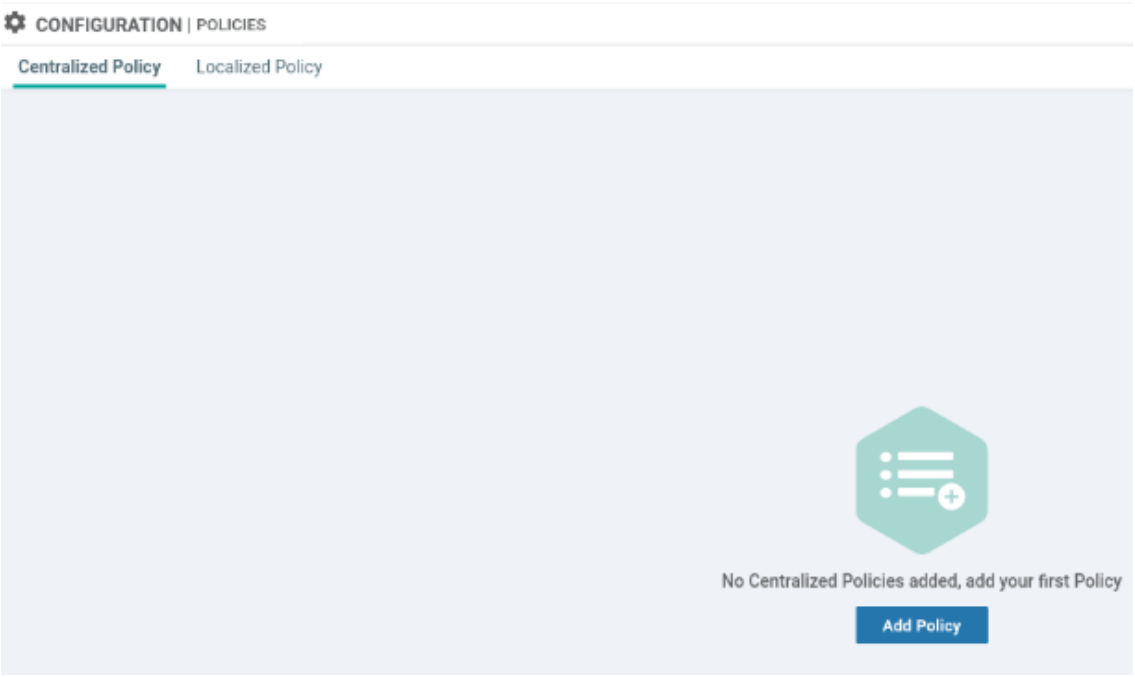
3. Repeat the same from the perspective of vEdge-DRC-Cyber.



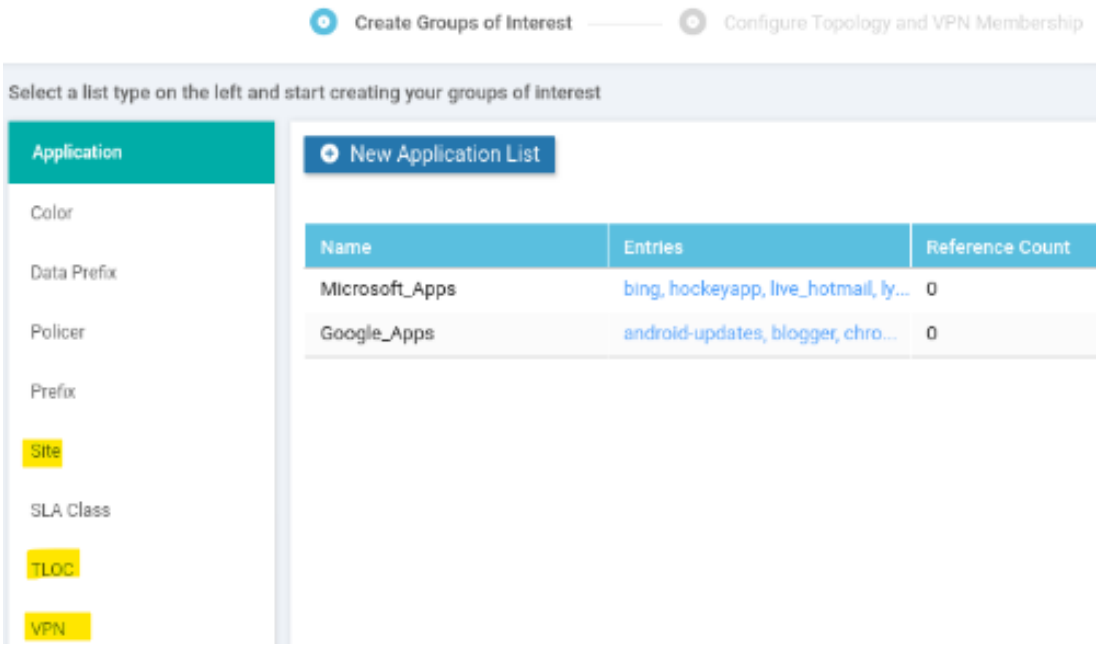
4. We will configure all traffic between sites to first pass through vEdge-HO (HUB).

// Configuring Hub & Spoke Template

1. Go to Configuration > Centralized Policy, then 'Add Policy'.

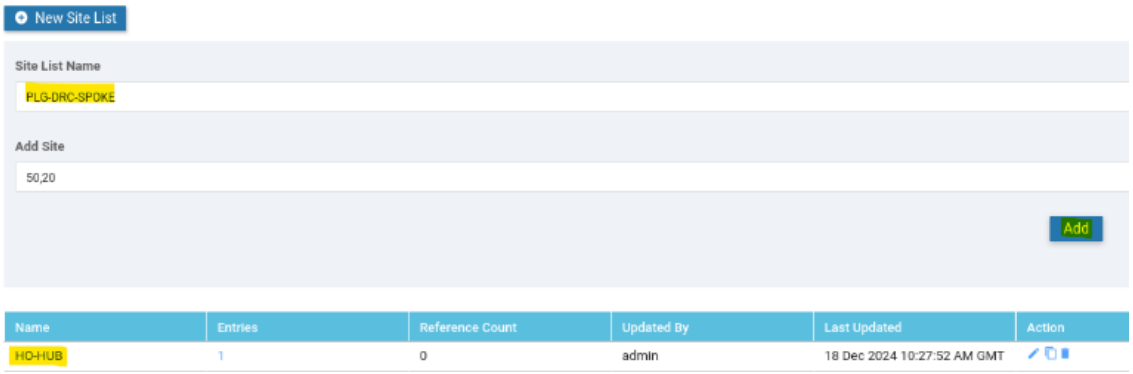


2. In the ‘Group of Interest’ section, we will add parameters such as Site, TLOC, and VPN.



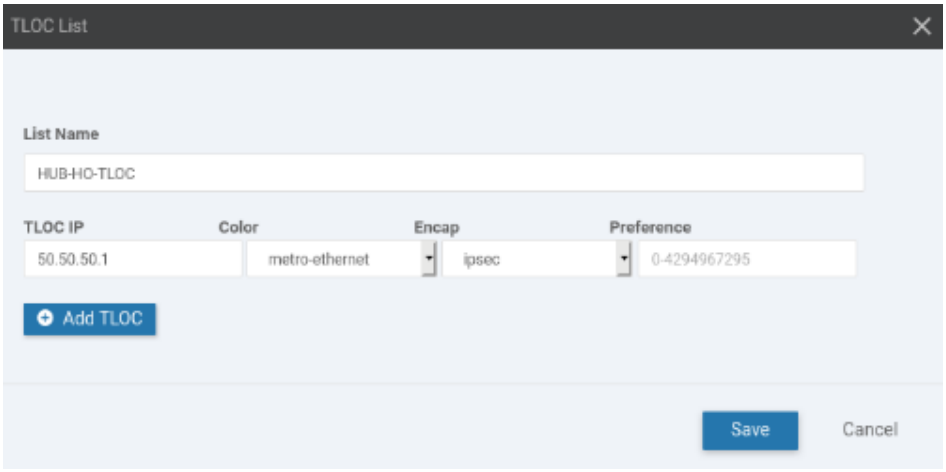
3. **[Group of Interest – Site]**

   Add ‘New Site List’ and designate Site HO as Hub, and Sites PLG and DRC as spokes. Click ‘Add’.



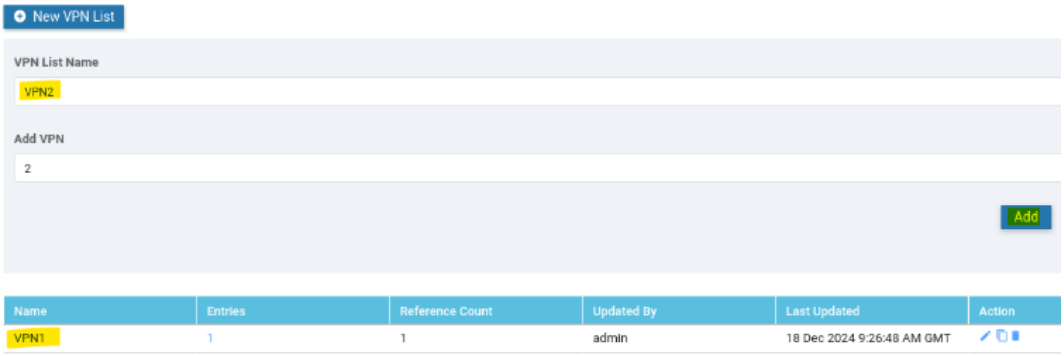
4. **[Group of Interest – TLOC]**

   Add 'New TLOC List' and input the TLOC information from vEdge-HO (Hub). The TLOC IP should match the system IP of the device, adjust the Color, and set the Encapsulation to IPsec. Then, click 'Save'.

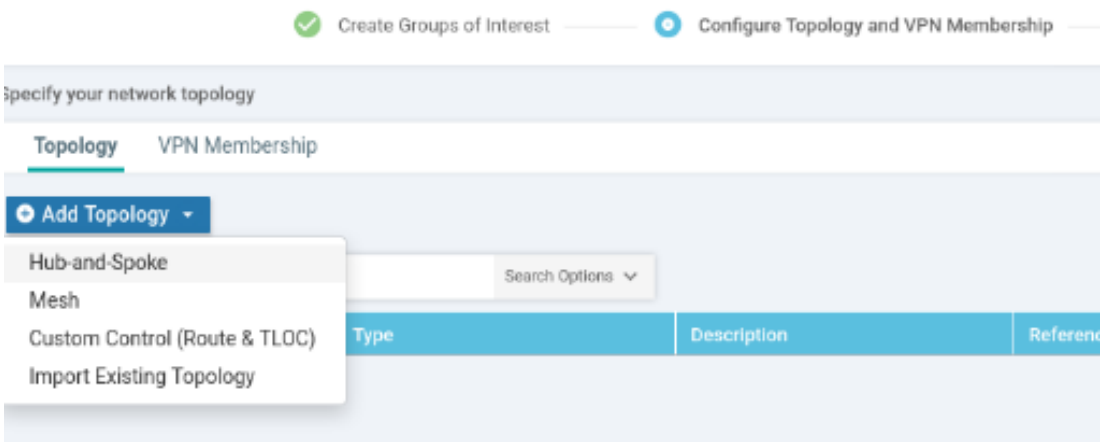


5. **[Group of Interest – VPN]**

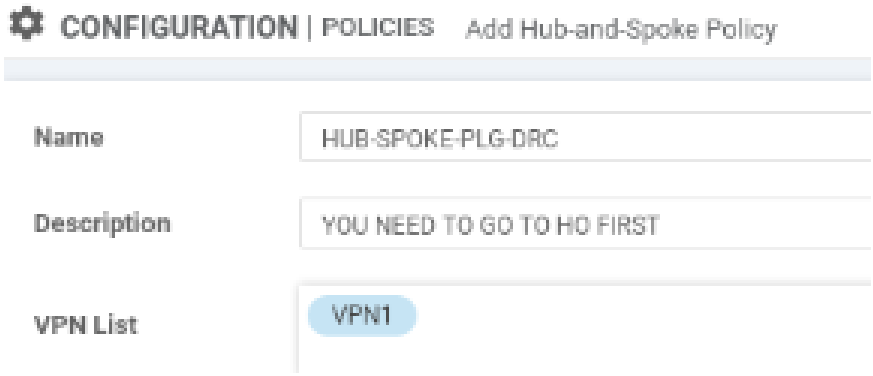
   Add the relevant VPN list operating.



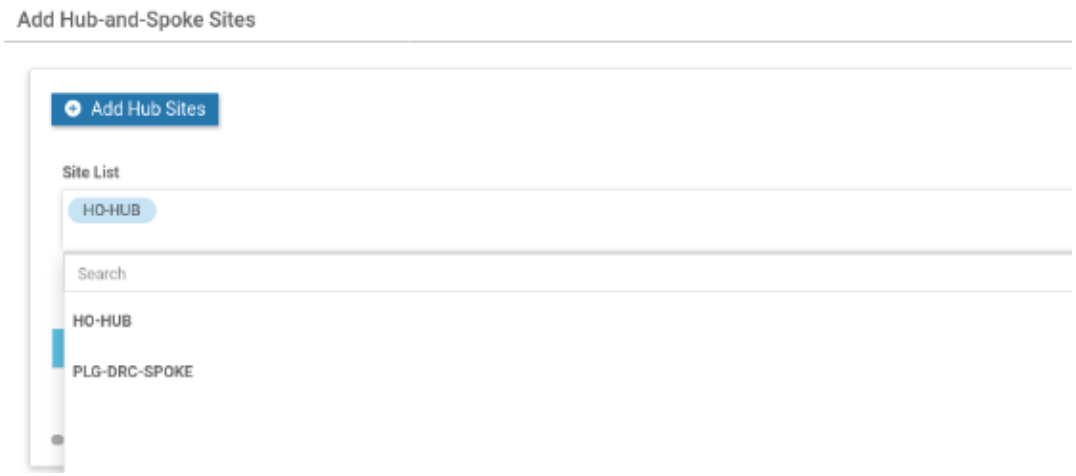
6. Then, click 'Next'. In the 'Configure Topology and VPN Membership' section, add 'Topology' and select 'Hub & Spoke'.



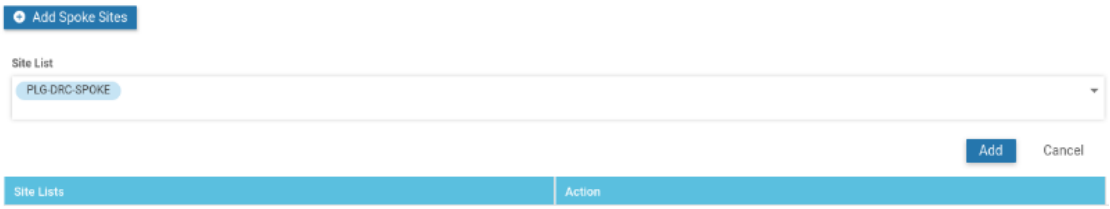
7. Name and describe the policy being created, then select the VPN list to be applied.



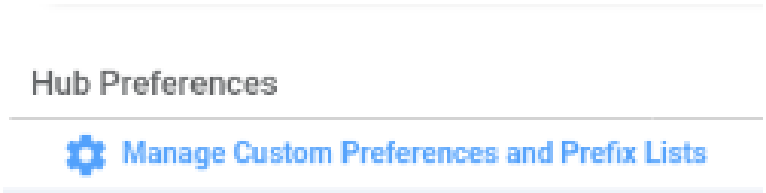
8. In the 'Add Hub & Spoke Sites' column, add the Site-list we created, for Hub Sites direct to HO-HUB, then 'Add'.



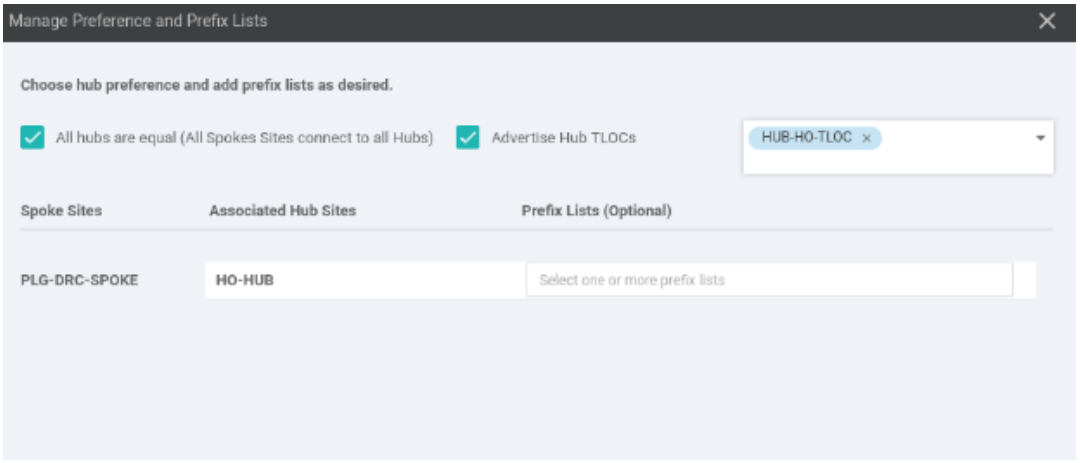
9. For Spoke-Sites, direct to PLG-DRC-SPOKE, then 'Add'.



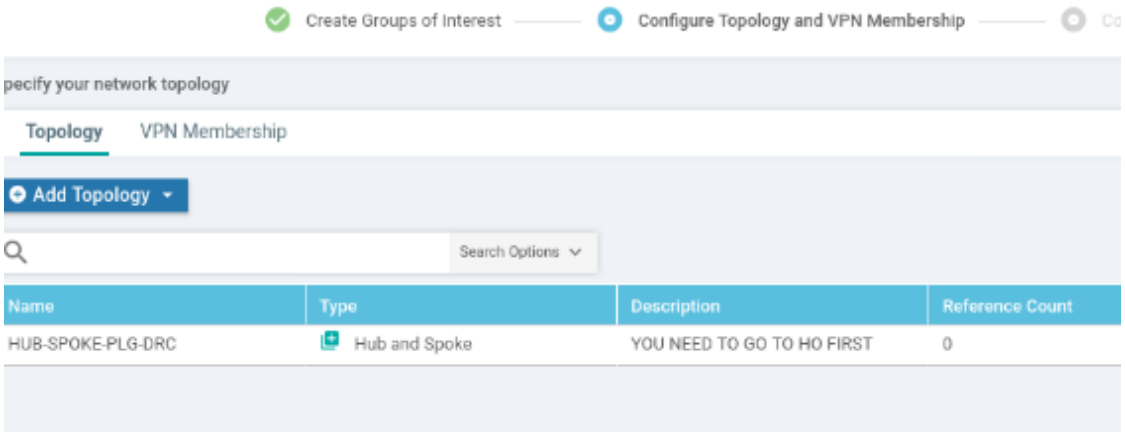
10. Then, a setup for 'Hub Preferences' will appear, click on the option.



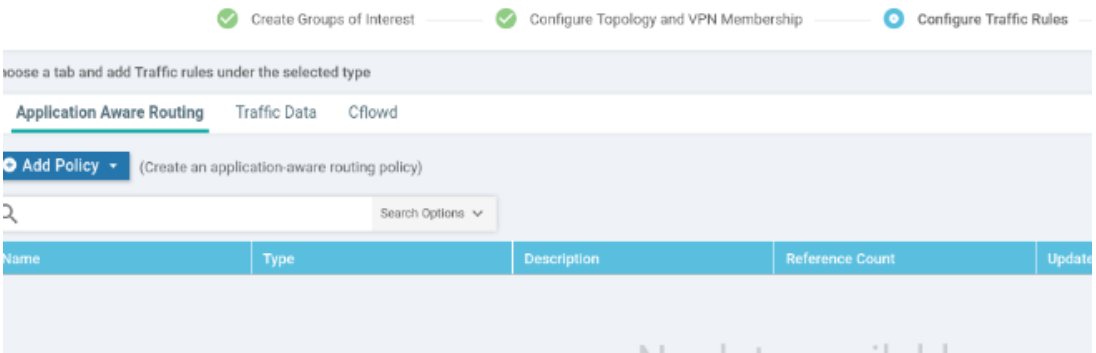
11. Check ‘Advertise Hub TLOC’, then direct to ‘HUB-HO-TLOC’ that was created, then ‘Save Changes’.


Manage Preference and Prefix Lists
Choose hub preference and add prefix lists as desired.
All hubs are equal (All Spokes Sites connect to all Hubs)
Advertise Hub TLOCs
HUB-HO-TLOC
Spoke Sites
Associated Hub Sites
Prefix Lists (Optional)
PLG-DRC-SPOKE
HO-HUB
Select one or more prefix lists

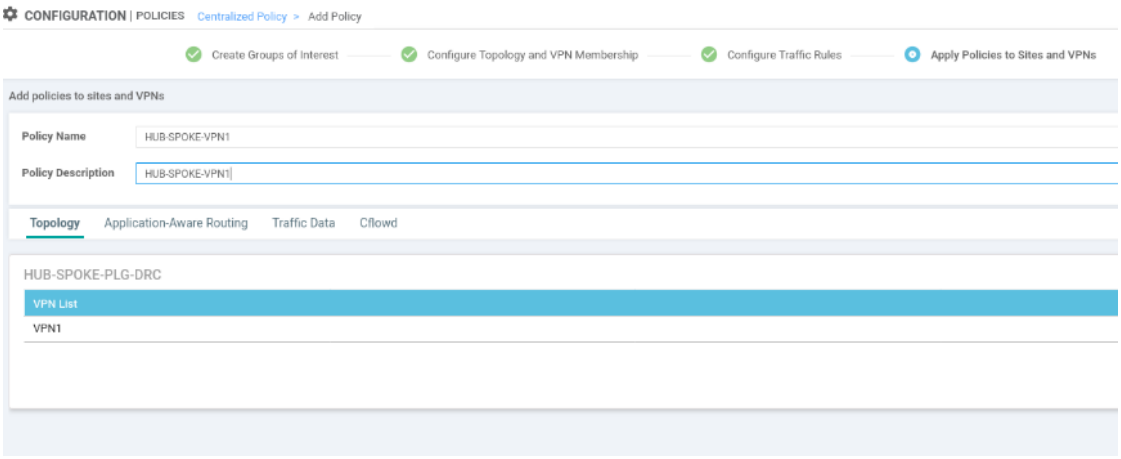
12. Once complete, ‘Save Hub & Spoke Policy’. The policy has now been successfully created.



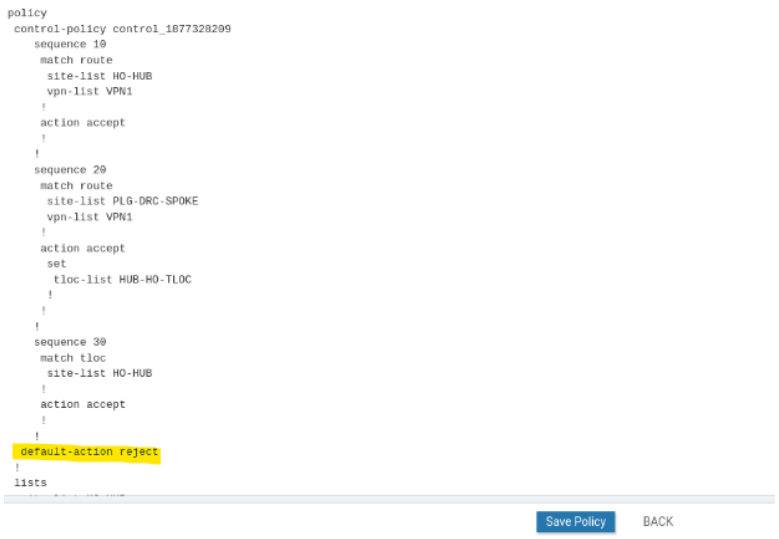
13. Click ‘Next’, skip the ‘Configure Traffic Rules’ section, and then click ‘Next’ again.



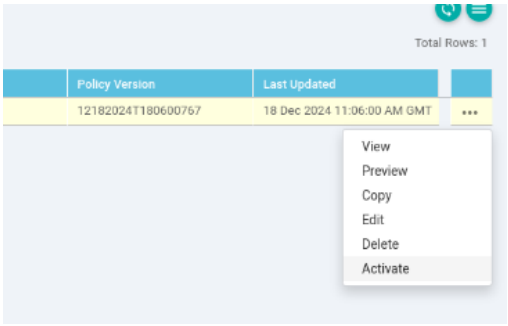
14. Lastly, in the 'Apply Policies to Sites and VPN', input the name and description of the policy.



15. Perform a 'Preview' to confirm the configuration before pushing it to vSmart. The 'default-action reject' ensures that every spoke must go through the hub first. Once verified, click 'Save Policy'.



16. Activate the policy that was created, and thus the Hub & Spoke configuration will be pushed to vSmart.



17. The Hub and Spoke configuration has been successfully pushed to vSmart.

```
vSmart1# show running-config policy
policy
 lists
  vpn-list VPN1
   vpn 1
  !
  tloc-list HUB-HO-TLOC
   tloc 50.50.50.1 color metro-ethernet encap ipsec
  !
  site-list HO-HUB
   site-id 1
  !
  site-list PLG-DRC-SPOKE
   site-id 20
   site-id 50
  !
 !
 control-policy control_1877328209
  sequence 10
   match route
    site-list HO-HUB
    vpn-list  VPN1
   !
   action accept
   !
  !
```

// After Scenario (Unreachable Spoke Solved)

After implementing Hub & Spoke, there is an issue where spoke devices only have OMP routes from the Hub, resulting in a problem with reachability to prefixes behind the spoke/vEdge devices.

```
VPN    PREFIX              PROTOCOL         SUB TYPE  IF NAME     ADDR             VPN      TLOC IP          COLOR
-------------------------------------------------------------------------------------------------------------------
1      20.20.20.20/32      ospf             IA        loopback0   -                -        -                -
1      20.20.20.20/32      connected        -         loopback0   -                -        -                -
1      35.35.35.1/32       omp              -         -           -                -        55.55.55.1       metro-et
1      172.16.1.0/24       omp              -         -           -                -        55.55.55.1       metro-et
1      172.16.21.0/24      ospf             IA        ge0/3       -                -        -                -
1      172.16.21.0/24      connected        -         ge0/3       -                -        -                -
1      192.168.11.0/24     omp              -         -           -                -        55.55.55.1       metro-et
1      192.168.12.0/24     omp              -         -           -                -        55.55.55.1       metro-et
1      192.168.13.0/24     omp              -         -           -                -        55.55.55.1       metro-et
1      192.168.21.0/24     ospf             IA        ge0/3       172.16.21.10     -        -                -
1      192.168.22.0/24     ospf             IA        ge0/3       172.16.21.10     -        -                -
1      192.168.23.0/24     ospf             IA        ge0/3       172.16.21.10     -        -                -

vEdge-DRC-Cyber2(config-vpn-1)# do ping vpn 1 192.168.51.10
Ping in VPN 1
PING 192.168.51.10 (192.168.51.10) 56(84) bytes of data.
From 127.1.0.2 icmp_seq=1 Destination Net Unreachable
From 127.1.0.2 icmp_seq=2 Destination Net Unreachable
```

The solution to this is to **add a default route** on the vEdge-HO (Hub) with a **next-hop of 'null0'**, then advertise this default as an OMP (omp advertise static). This is used for routing simplification and to avoid routing loops. In short, every spoke will have a default route to the Hub. When a spoke wants to send packets to an unknown route, that route will be discarded (black hole) to prevent routing loops (going back and forth between the hub and spoke).

Config:

vEdge-HO(config)# **vpn 1**

vEdge-HO (config-vpn-1)# **ip route 0.0.0.0/0 null0**

vEdge-HO (config-vpn-1)# **omp**

vEdge-HO (config-omp)# **advertise static**

vEdge-HO (config-omp)# **commit**

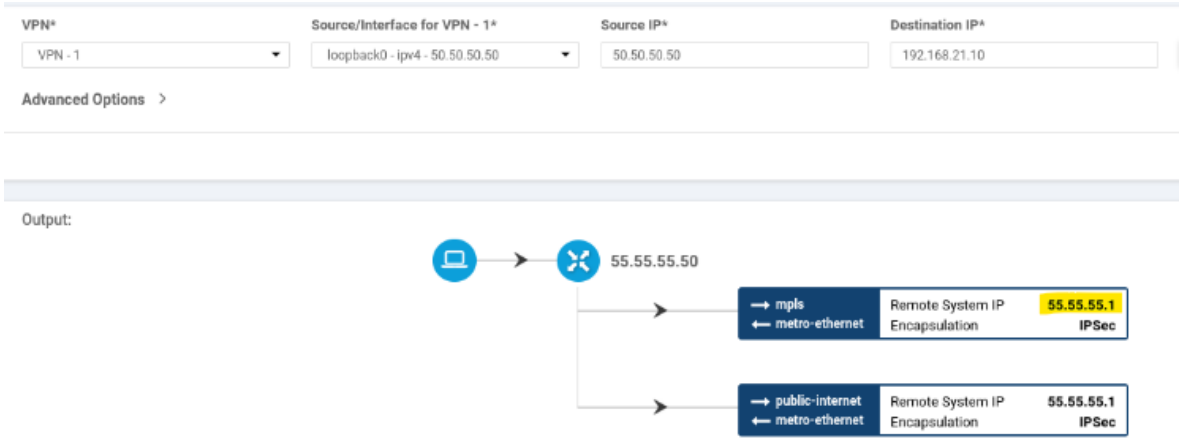
Commit complete.

So, after vEdge-HO (Hub) redistributes its default route to OMP, every spoke now has a default route going to the Hub, and reachability to Site 20 is now connected.

```
                                      PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN    PREFIX              PROTOCOL   SUB TYPE  IF NAME     ADDR             VPN      TLOC IP
-------------------------------------------------------------------------------------------------
1      0.0.0.0/0           omp        -         -           -                -        55.55.55.1
1      20.20.20.20/32      ospf       IA        loopback0   -                -        -
1      20.20.20.20/32      connected  -         loopback0   -                -        -
1      35.35.35.1/32       omp        -         -           -                -        55.55.55.1
^CAborted: by user
vEdge-DRC-Cyber2(config-vpn-1)# do ping vpn 1 192.168.51.10
Ping in VPN 1
PING 192.168.51.10 (192.168.51.10) 56(84) bytes of data.
64 bytes from 192.168.51.10: icmp_seq=1 ttl=253 time=70.3 ms
64 bytes from 192.168.51.10: icmp_seq=2 ttl=253 time=87.8 ms
64 bytes from 192.168.51.10: icmp_seq=3 ttl=253 time=86.9 ms
64 bytes from 192.168.51.10: icmp_seq=4 ttl=253 time=87.7 ms
```

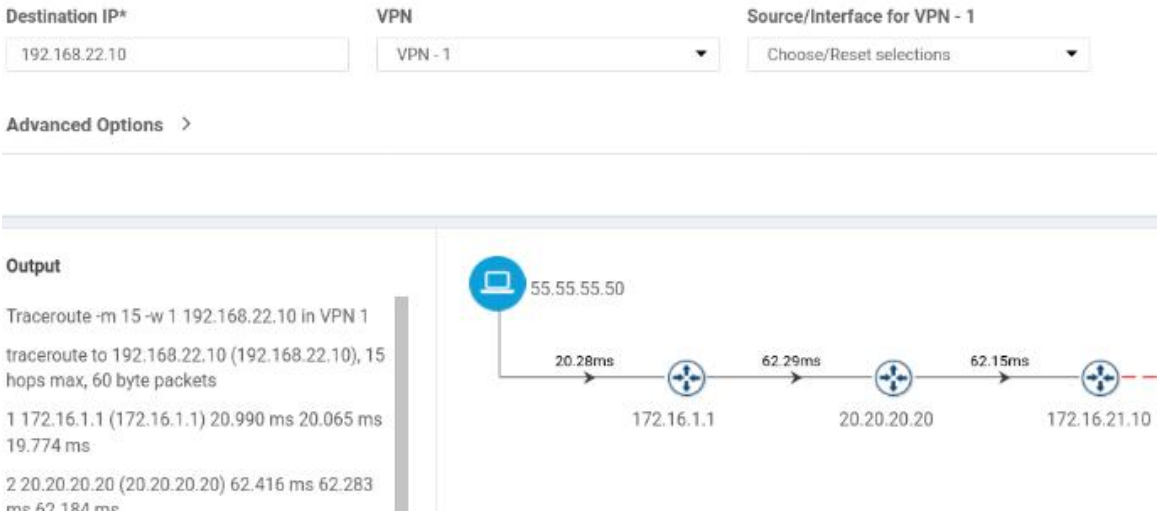
```
                                      PROTOCOL  NEXTHOP     NEXTHOP          NEXTHOP
VPN    PREFIX              PROTOCOL   SUB TYPE  IF NAME     ADDR             VPN      TLOC IP
-------------------------------------------------------------------------------------------------
1      0.0.0.0/0           omp        -         -           -                -        55.55.55.1
1      35.35.35.1/32       omp        -         -           -                -        55.55.55.1
1      50.50.50.50/32      ospf       IA        loopback0   -                -        -
1      50.50.50.50/32      connected  -         loopback0   -                -        -
^CAborted: by user
vEdge-PLG1(config-vpn-1)# do ping vpn 1 192.168.22.10
Ping in VPN 1
PING 192.168.22.10 (192.168.22.10) 56(84) bytes of data.
64 bytes from 192.168.22.10: icmp_seq=1 ttl=253 time=71.4 ms
64 bytes from 192.168.22.10: icmp_seq=2 ttl=253 time=73.8 ms
64 bytes from 192.168.22.10: icmp_seq=3 ttl=253 time=73.6 ms
```

// Traffic flows



Traffic is first directed to vEdge-HO/Hub.

// Traceroute




```
DRC1-CYBER2#traceroute 192.168.52.10
Type escape sequence to abort.
Tracing the route to 192.168.52.10
VRF info: (vrf in name/id, vrf out name/id)
  1 172.16.21.1 13 msec 17 msec 21 msec
  2 172.16.1.1 51 msec 49 msec 52 msec
  3 50.50.50.50 83 msec 89 msec 82 msec
  4 172.16.51.171 102 msec 75 msec *
```

Traffic goes first to vEdge-HO/Hub.

REFERENCES

- https://www.youtube.com/watch?v=do_Tcdyw6vo&list=PLxyr0C_3Ton1mWNeKEnDtIgqZS_fQKQyL
- https://www.youtube.com/watch?v=LA2iZCX76sI&list=PLpfp_h7oipaS45E1JYvuBi0ypzJOKhJ1c
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- https://www.networkacademy.io/ccie-enterprise/sdwan